EUROCHAMBRES

Final Report

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THE CIRCULAR ECONOMY
Challenges, Opportunities and Pathways for European Businesses

Executive Summary

The circular economy is expected to become one of the greatest societal and economical disruptors of our time. The linear model representing the way we manufacture and consume already represents an important constraint to society and the economy, and may become obsolete and potentially detrimental to European businesses in the not-so-far future, due to a combination of factors related, inter alia, to virgin resources' depletion and climate change. This is why action is needed to understand the factors leading to this inefficiency, and create constructive strategies that support competitiveness, as well as social and economic resilience and prosperity.

The analysis is an EUROCHAMBRES initiative launched in order to better understand if and how the circular economy will benefit European businesses, and to delineate a successful transition. This will be the basis for a policy strategy elaborated to contribute to an enriching debate on future legislative proposals at European level.

This report is a comprehensive meta-analysis compiling the most up-to-date quantitative studies on the circular economy, and elaborates on nine industrial sectors including case studies. Bearing in mind the future of European manufacturing industries and businesses, the paper focuses on European trends derived from the available data.

- **For metal manufacturers, resource efficiency measures amounting to € billion 570 are expected to lead to overall annual benefits of € billion 44-82 for the industry in the EU-27 Member States and average annual economic benefits of € 164,000 per company.**
- **In the food and drink manufacturing sector, € billion 760 investment costs would be needed to increase resource efficiency, and are estimated to bring € billion 64 – 118 in annual gross benefits for the sector in the EU. This would translate into € 424,000 of annual economic benefits per company.**
- **The economic potential of a circular model in the agricultural sector is expected to bring benefits amounting to € billion 92 between the period 2016-2030, through a € billion 72 investment. The benefits include lower costs in fertilizer and pesticide inputs, as well as costs for machinery and GHG emissions.**
- **In the hospitality and food service sector, the opportunity in achieving high resource efficiency would cost an estimated € billion 100 in total, and offer net benefits of € 27,500 per company,**

or 10% of the average turnover. The total annual benefit in the sector would amount to € billion 64-118.

- **For the automotive industry, by 2030 up to € billion 175 in annual societal cost savings (e.g. congestion, increase of urban spaces) can potentially be attained by investing € billion 100 during the period 2016-2025. This would need to see the transportation sector rapidly transitioning toward shared, modular and electric vehicles. The industry's revenues are expected to grow by 4.4% annually.**
- **The construction sector will need remarkable developments in terms of design and production of circular buildings, as well as incrementing its recyclability and reusability potential. In total, in Europe € billion 107 would be needed between 2016-2025 to convert the current system into a circular one. This would lead to € billion 150 forecasted in financial benefits by 2030, mainly in cost savings for the sector.**
- **In the plastics sector no comprehensive cost-benefit analysis can be found in the literature, but strong evidence was found for economic benefits residing in the concepts of design for reuse and recycling, as well as coastal waste management.**
- **The textile sector is not covered by comprehensive cost-benefit analysis for the EU, but in the report main disrupting opportunities were depicted to convert the industry from a linear to circular model. These include the introduction and development of more resource efficient fabrics, leasing services, more durable fabrics and clothes, recycling of textile waste or discarded clothing, and an improved network for the second-hand market. Globally, overall annual benefits are estimated to amount to € billion 161 -land use externalities excluded-, if the fashion industry addressed its societal and environmental externalities.**
- **The electronics industry is still lacking a fully functioning recycling and repairing system, which is a good example for economic inefficiency. For this reason, the revenue potential for Waste Electrical and Electronic Equipment (WEEE) recycling in Europe is calculated to become billion € 2.15-3.67 by 2020.**

Introductory Remarks

EUROCHAMBRES is the Association of European Chambers of Commerce and Industry. As such, we represent 45 member organisations from 43 countries. 1,700 regional Chambers work for more than 20,000,000 companies, the vast majority being SMEs, employing over 120,000,000 people across the continent.

We therefore do not represent individual sectors of the European economy but proud ourselves to stand for the entire business community. This also means that we do not represent any particular interest, but always have to keep in mind the overall concerns of the economy. A holistic approach taking into consideration different interests and needs ensures balanced policy actions.

It is in this spirit that we launched the present analysis of the Circular Economy in Europe. The business community is well aware of its crucial role in tackling the environmental challenges of our time, yet the transition to a fully-fledged Circular Economy has to make both economic and ecological sense. Only then will Europe succeed in creating wealth while at the same time sustainably managing the environment for future generations. The aim is to examine if and how the circular economy will benefit European businesses, and to delineate a successful transition. The paper as well as the following discussions with stakeholders, namely the European Institutions, other business organisations, businesses themselves, research and NGOs will be the basis for a policy strategy elaborated to contribute to an enriching debate on future legislative proposals at European level.

Table of contents

1. Introduction

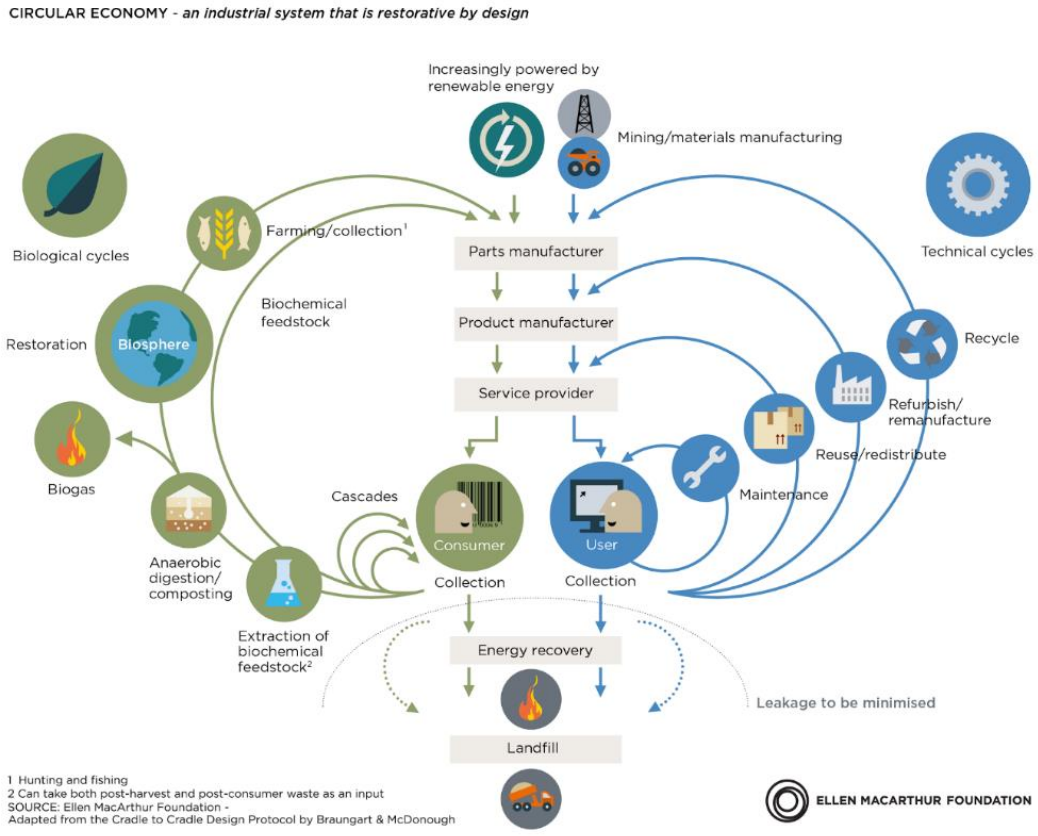
In contrast with the "take-use-dispose" paradigm that defines the linear model, in a circular economy scenario resources are continuously repurposed, in order to be kept in use as much as possible.
The circular economy concept rests on three principles, built upon numerous schools of thought[1], and clearly summarised by the Ellen Mac Arthur Foundation:

- **Loop of products and materials**
- **Regeneration of natural systems**
- **Phasing out of waste and pollution**

The same Foundation introduced the concept of 'circular economy' as "an industrial economy that is restorative or regenerative by intention and design".[2] Building on this definition, and the ones coined by numerous studies, Geissdperfer et al.[3] describes the concept as:

"A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse remanufacturing, refurbishing, and recycling."

Figure 1: The Circular Economy scheme[4]



[1] Namely: Cradle to Cradle, Performance Economy, Biomimicry, Industrial Ecology, Natural Capitalism, Blue Economy, Regenerative Design.
[2] Ellen MacArthur Foundation. (2013). *Towards the Circular Economy*. vol. 1 (Isle of Wight).
[3] Geissdoerfer, M., Savaget, P., Bocken, N., & Hultink, E. (2017). *The Circular Economy – A new sustainability paradigm?.* Journal Of Cleaner Production, *143*, 757-768. doi: 10.1016/j.jclepro.2016.12.048
[4] Ellen Mac Arthur Foundation. (NA)*. Infographic- Circular Economy System Diagram*. Retrieved 25 August, 2018, from https://www.ellenmacarthurfoundation.org/circular-economy/infographic

It is upon these definitions that this report was structured, in order to give a general but clear overview of challenges and opportunities stemming from the most up-to-date studies for nine different industrial sectors. This paper presents four main sections:

1. an Introduction, where the report is being presented along with its objectives and limitations;
2. A summary of the Circular Economy Package legislations;
3. An Analysis on nine industrial sectors, where the main results are being presented;
4. And a Conclusion.

1.1 Methodology and objectives of the research

While the concept is receiving a growing interest from European institutions and businesses, investments are still very low to put Europe in a circular pathway.[5] EUROCHAMBRES is convinced that with the right regulatory and economic incentives, the full potential of the circular economy can be exploited, but thinks it is important to correctly understand the pathways of this transition for business.

While the report will not specifically touch the policy aspect, its role will be rather to understand and analyse the future business opportunities that lie within the circular economy, in nine industrial sectors: agriculture, construction, mobility, hospitality and food services, metal manufacturing, electronics, textile, food & drink manufacturing, and plastics.

In order to assess the impact of the circular economy on the industry, numerous studies have been produced to analyse the future impact through complex modelling and scenario analysis. The most relevant and updated reports have been reviewed and utilized in this report to address the most recent findings. The analysis has been effectuated on a sectorial basis, in order to delineate common saving mechanisms and have a clearer overview of the numerous transformations taking place at different levels of the productive and industrial world. Furthermore, the trends and data are presented in a solution-based approach, so as to concentrate the most relevant and effective information with the word and time limit given.

The economic and financial indicators that were able to be extracted are the following: investment costs, cost savings, and investment opportunities. Furthermore, sectorial processes for saving mechanisms and future industry disruptors, along with case studies will also be present to offer a wider understanding of the current scenario, and portray some of the thoughts and challenges of the actors already involved in the transition to a circular economy. The case studies are based on interviews which were adapted according to sector and company. Due to the different interview settings, and the diversity of the speakers and sectors analysed, each case study presents an original and unique format that was adapted accordingly to the style and context of the interviews.

1.2 Limitations

At the business level, the competitive conditions in the EU are putting pressures on companies to create more efficient value chains, to reduce costs on production, through for example, reduced waste and resource usage. The cost savings obtained can be passed to consumers, or used as safety-nets for businesses. It remains however very difficult to predict companies' moves, and modelling the overall costs and benefits of the numerous scenarios. Hence the limitations of this report.

The overall limitations stem from various factors:

[5] Ellen Mac Arthur. (2015). *Growth Within: a Circular Economy Vision for a Competitive Europe*. pp 12. Retrieved July 25, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

- The analysis presents overlaps in terms of the industrial sectors concerned, due to inconsistency in the literature and obvious overlap of activities between various sectors (e.g. plastics and food & beverage). In this case, the data is presented in the most relevant sections;
- The modelling methodologies for scenario analysis used in the showcased studies are often times not present in the original studies, or show strong limitations and assumptions;
- The literature is still largely uncomplete when it comes to conducting comprehensive cost-benefit analysis (CBA) studies. It is the case in several sectors analysed in this report.
- Sufficient data wasn't found to balance, or confirm, some of the quantitative figures originating from the studies conducted by the Ellen Mac Arthur Foundation and McKinsey & Company.

2. The Circular Economy Package

The European Commission has set a number of objectives to promote the transition to a circular economy. These objectives are englobed in a number of legislative Directives that together represent the EU Circular Economy Package, which was presented in December 2015. The targets that were first presented in 2015 were four all waste-related Directives, with the fifth – on marine litter- recently proposed in May 2018:

2015

- Waste Framework Directive;
- Landfilling Directive;
- Packaging Waste Directive;
- Directive on End-of-life vehicles, Batteries and Accumulators and Waste Batteries, and Waste Electrical and Electronic Equipment -ELV/Batteries/WEEE-.

2018

- Single-use plastics Directive.

The Circular Economy Package has since its creation been represented by an EU Action Plan, which represents the concrete programme of actions for the implementation of the legislations to be proposed. Within the EU Action Plan for the Circular Economy, we find actions outside of the Circular Economy Package scope, such as: the Eco-design Directive, the Fertilisers Directive, and discussions, reports or assessments covering themes like the Bioeconomy, Critical Raw Materials, Food Waste, and many more.[6]

Waste Framework Directives[7]

Introducing the "polluter pays principle" and the ''extended producer responsibility -EPR-'', the Directive 2008/98/EC sets the basic concepts concerning waste management practices -waste, recycling, recovery- in the EU.

The legislation, within the most important developments, also establishes a waste hierarchy, distinguishes between waste and by-products, includes the regular inspection of producers or holders of waste and introduces recycling and recovery targets to achieve, by 2020, a 50% rate for household waste, and 70% for construction and demolition waste (CDW).

[6] EC. (2015) Communication From the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions Closing the loop - An EU action plan for the Circular Economy, Document 2. Retrieved 5 December, 2018, from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0614&from=EN

[7] EP. (2008). O*n waste and repealing certain Directives.* Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098

Recently revised by the Council -May 2018-, the legislative waste package established new binding targets for recycling, which see rates increasing from 55% by 2025 to 65% by 2035. The legislation also defines targets for packaging that between the years 2020-2030 will see recycling rates grow from 65% to 70%.

Landfilling Directive[8]

Entered into force in July 1999, the Landfill Directive defines the different categories of waste -municipal waste, hazardous waste, non-hazardous waste and inert waste- and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land.

The Directive decides the kind of waste that is and is not accepted in landfills, creates a system of operating permits for landfill sites and the procedures for acceptance of waste into the landfills.

Packaging Directive[9]

The Packaging Directive was introduced in the early 80's and covers all packaging entering the European market and packaging waste, and provides measures targeting the reduction of packaging waste and promoting recycling, re-use and other forms of waste recovery.

The review of the Directive in 2015 saw recycling rates targets increase. In article 6 the following targets are presented:

By December 31st of 2025 European countries must comply to packaging recycling rates of accordingly: 50% for plastics, 60% for wood, 75% for ferrous metals, 75% for aluminium, 75% for glass, 75% for paper and cardboard.

By December 31st of 2030 instead, recycling rates will have to be the following: 55% for plastics, 75% for wood, 85% for ferrous metal, 85% for aluminium, 85% for glass, 85% for paper and cardboard.

As a matter of comparison, in 2008, the same Directive set the following targets: 60% for glass, paper and cardboard, 50% for metals, and 22.5% for plastics, and 15% for wood.

Directive ELVs vehicles[10]

Introduced in the year 2000, the Directive sets out measures to prevent and limit waste from end-of-life vehicles -ELVs- and their components, and ensures that these are reused, recycling or recovered where possible.

Some of the major regulations are listed here as following:

-Ban of the use of hazardous substances such as lead, mercury and cadmium;

-Obligations of annual reporting on disposed ELVs to member countries;

-Standards for the removal and disposal of vehicles, ensuring that new vehicles are reusable and/or recyclable to a minimum of 85%, and reusable and/or recoverable to a minimum of 95% by weight;

-Gives the producers the responsibility of transporting the vehicles in the designated treatment centres.

[8] EP. (1999). *Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.* Retrieved from https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A31999L0031
[9] EP. (2014). *Packaging and packaging waste.* Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l21207
[10] EC. (2018). *End-of-life vehicles- Legislation.* Retrieved from http://ec.europa.eu/environment/waste/elv/legislation_en.htm

Directive on Batteries and Accumulators and Waste Batteries [11]

This legislation prohibits the placing on the market of most batteries and accumulators with a certain mercury or cadmium content and establishes rules for the collection, recycling, treatment and disposal of batteries and accumulators.

Regarding the presence of mercury, the Directive prohibits batteries and accumulators containing more than 0,0005 % by weight of mercury. Cadmium contents in portable batteries and accumulators cannot surpass 0,002% of weight.

Collection targets in 2016 were of 45%, even though reports have observed that only seven member states have attained the targets.[12] On the other hand recycling targets are in the order of 65% for lead, 75% for cadmium and 50% for all other materials, and these have to be obtained by using the best available techniques.

Waste Electrical and Electronic Equipment (WEEE) Directive[13]

Applied since August 2012, and incorporated into national laws in February 2014, the Directive is designed to prevent WEEE, creating ground for the recovery, reuse and recycling of produce.

After not achieving the expected results, the legislation was modified in 2016, increasing the collection of electronic waste from 4 kg of annual waste per inhabitant, to a national target of 45% of the annual weight. In 2019 the target should increase to 65%.

The Directive places responsibility on producers to cover the costs of collecting, treating and -sustainably- disposing of waste at determined collection areas.

Single Use Plastics Proposal[14]

The most recent legislative proposal of the Circular Economy Package was proposed in the European Commission in May 2018, and is now waiting to be fully adopted by the Council. Political agreement has been reached in December 2019.

The Directive cuts down on ten single-use plastic products -e.g.: plastic cotton buds, cutlery, plates, straws-, while obliging Member States to reduce the use of plastic food container and drink cups. Producers will be held accountable for part of the costs of waste management and clean-up, and awareness raising measures, both for single-use produce, fishing gears, and cigarette buds.

At least 25% of PET bottles has to be recycled plastic by 2025. This rate will be raised to 30% by 2030 for all plastic bottles.

3. ANALYSIS

On a global level, the McKinsey Global Institute estimated that a full capture of the resource efficiency and productivity potential could trigger € trillion 2.1 in annual cost savings in 2030.[15] On a parallel note, the same

[11] EP. (2006). *On batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC.* Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32006L0066
[12] Linnenkoper., K. (2016). *EU Struggles Towards 45% battery collection target*. Retrieved October 10, 2018, from https://recyclinginternational.com/e-scrap/eu-struggles-towards-45-battery-collection-target/
[13] EC. (2011). *Waste Electrical & Electronic Equipment (WEEE).* Retrieved from http://ec.europa.eu/environment/waste/weee/index_en.htm
[14] EC. (2018). *Proposal for a Directive of the European parliament and of the council on the reduction of the impact of certain plastic products on the environment*. Retrieved from http://ec.europa.eu/environment/circular-economy/pdf/single-use_plastics_proposal.pdf
[15] McKinsey Global Institute. (2011). *Resource Revolution: Meeting the world's energy, materials, food and water needs.* Retrieved August 25, 2018, from

study found that approximately € billion 775 are globally required every year to subsidize the consumption of resources. A factor that puts serious pressures on governments' financial stability.

The Ellen Mac Arthur Foundation, together with SUN and McKinsey, estimated that the circular economy in Europe can create a net benefit of € trillion 1.8 by 2030 -negative externalities included. This would translate to a GDP increase of 7%, or € trillion 0.9 relative to the current scenario.[16]

Benefits for European companies can be seen at the macro-level. Product level modelling conducted by the Ellen Mac Arthur Foundation estimated that the circular economy represents for European firms an annual cost saving opportunity up to € billion 285 for a 'transition scenario'[17] and up to € billion 473 for an 'advanced scenario'.[18] [19]

In the following paragraphs, the analysis will focus on the nine specific industrial sectors.

3.1 Metal Manufacturing

A study conducted in 2013 by Amec and Bio Intelligence Service,[20] studied the cost saving potential of resource efficiency measures for the metal manufacturing -as well as for the hotel and restaurants, and food and beverages sectors. This study is the predominant source for the economic analysis for the sector, as data remains very limited throughout the literature.

Although not fully satisfactory, the report by Amec et al. gives an overview of possible opportunities that currently remain untapped in the sector. For the cost and benefit analysis of the study, an Eurobarometer survey conducted in 2012[21] was used. For the calculations, the costs have been allocated over a period of 10 years at a discount rate of 10%.

In the manufacturing sector, materials and supplies are estimated to represent an average of 30 – 45% of a company's total costs.[22] As a report, conducted in 2011 by Trucost[23] and analysing the economic margin of 350 FTSE companies, demonstrated, material costs have been on a steady rise for years due to scarcity of a large number of resources, which in return cause the commodity prices to increase. It can therefore represent a strategic move for companies to invest in more resource efficient operations.

https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability%20and%20Resource%20Productivity/Our%20Insights/Resource%20revolution/MGI_Resource_revolution_full_report.ashx

[16] The Ellen Mac Arthur Foundation. (2015). *Towards a circular economy: Business rationale for an accelerated transition.* Retrieved August 25, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/TCE_Ellen-MacArthur-Foundation_9-Dec-2015.pdf

[17] *Transition scenario: considered the pioneering phase between 2015-2020; Advanced scenario: mainstreaming phase looking at the 2020-2025 period.

[18] The Ellen Mac Arthur Foundation. (2013). *Towards the circular economy- vol. 1.* Retrieved August 27, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

[19] Euro data obtained from USD 2013 conversion ratio.

[20] Amec & Bio Intelligence Service. (2013). *The Opportunities to Business of Improving Resource Efficiency*. Retrieved July 20, 2018, from http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/report_opportunities.pdf

[21] TNS Political & Social. (2012). *SMEs, Resource Efficiency and Green Markets*. Flash Eurobarometer 342. Retrieved from https://publications.europa.eu/en/publication-detail/-/publication/3e0eeaef-0259-11e8-b8f5-01aa75ed71a1/language-en

[22] Greenovate. (2012). *Guide to resource efficiency in manufacturing*. Retrieved from https://www.greenovate-europe.eu/sites/default/files/publications/REMake_Greenovate%21Europe%20-%20Guide%20to%20resource%20efficient%20manufacturing%20%282012%29.pdf

[23] Trucost. (2011). FTSE 350 Commodity Exposure Index.

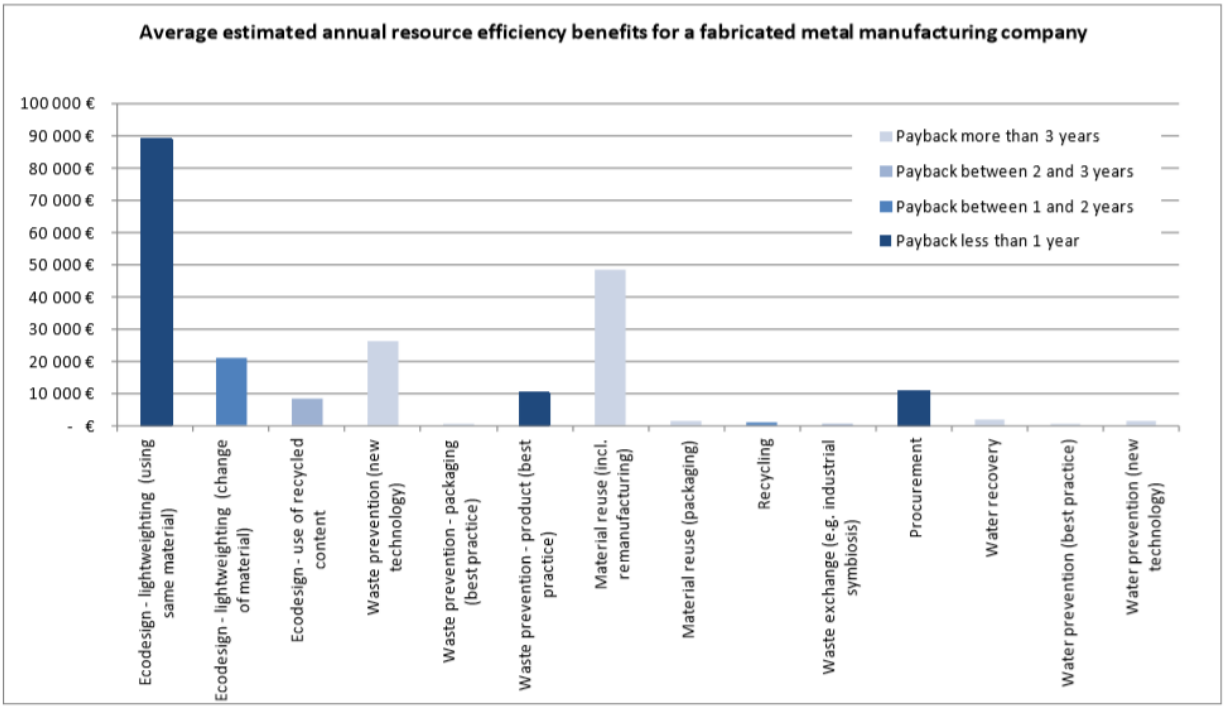
Table 1: Structural business statistics in the metal manufacturing sector[24]

Number of companies	406,617
Number of Persons employed	4,121,502
Average of employees	10
Average company turnover (million €)	1.31

Although not representative of the industry, as employment is concentrated in a few large companies and micro-companies, the average data helps to obtain a general overview of the sector to better understand the analysis. The data was purposefully not updated to current trends in order to ease the analysis.

Annually, total materials, water and waste management costs account for 28% of the average company's turnover in 2014, or € 361,591. With an estimated total sum of about € billion 570 investment costs in the first year and in the overall sector,[25] economic benefits for all EU-27 are calculated to be € billion 44-82 per year. On average, by undertaking resource efficient measures, a company is estimated to receive annual benefits amounting to € 164,000, or 17% of the sector's annual average turnover.

Figure 2: The average annual benefits of resource efficiency measures for a metal manufacturer in the EU[26]



As shown in Figure 2, the study suggests that the most efficient measures for resource savings in the metal manufacturing sector are in order of scale of investment: **eco-design** (light weighting), **reusing materials in a closed loop system** (such as remanufacturing), **waste prevention** (using production processes that do not create waste), and **changing procurement practices**. In total, these measures would result in cost savings of €160,000 (16% of an average company's turnover), with a payback of less than 1 year (for eco-design and procurement) and more than 3 years (for material reuse and waste prevention measures).

[24] Eurostat. (2008, or latest year available). European Business Statistics data.
[25] Amec & Bio Intelligence Service. (2013). *The Opportunities to Business of Improving Resource Efficiency*. pp 94. Retrieved July 20, 2018, from http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/report_opportunities.pdf
[26] IDEM, pp 64.

The main two cost saving measures, eco-design and material use account for 60% of the total potential benefit, where eco-design represents 40% of the total saving.

The top two measures account for over 60% of the total maximum potential benefit for the fabricated metal products sector. These are eco-design (40%) and material reuse (22%). They reflect the main activities in the sector and use of materials. The third measure is waste prevention using new technology (12%).

It is important to note at this point that some of the measures proposed are targeted towards upstream activities, while others rather to downstream activities. As an example, eco-design requirements directly affect SMEs at the end of the material stream, whereas changing procurement practices and waste prevention will impact both upstream and downstream industries. Indirect effects of these measures on upstream companies must be taken into consideration in the design of legislation.

AURUBIS- metal manufacturer and recycler

Aurubis

Founded in 1866, Aurubis is today one of the European leader experts in copper production as well as in recycling copper scrap and metallic materials. Every year, the company produces 1.4 million tons of copper products, while recycling 700,000 tons of raw materials of varying qualities and compositions, recovering valuable products such as copper, precious metals, iron silicate sand, and nickel sulphate. Total revenues in the year 2016-2017 were of € billion 11.04.

As an important supporter of the circular economy, the metal manufacturing and recycling company has consolidated several cooperations with other companies, such as Grillo, in order to close the loop of materials. Grillo is specialized in zinc sulphate production, used for the fibre, feed, and fertilizer industries. During the production of zinc sulphate, Grillo produces also other elements, resulting residues of the chemical process: copper, tin and lead. Aurubis takes these elements, and puts them back in its production cycle.
In terms of **policy recommendations**, Aurubis' position is clearly presented as following:

- Consider recyclability and durability in product design.
- Implement separate collection of waste streams at their source.
- Apply minimum operating conditions for Extended Producer Responsibility (EPR) schemes, adopting the principles of shared responsibility, transparency and accountability.
- Adopt ambitious, but pragmatic waste recycling targets and clearly define harmonized definitions and calculation method, bearing in mind the priority objective of moving from waste management to resource management (material recovery).
- Establish a mandatory EU certification scheme applicable to certain waste streams (e.g. WEEE and batteries), in order to provide the required framework for quality recycling of EU scrap.
- Implement measures to improve control at borders, in order to minimise illegal exports of waste.
- Facilitate trade of by-products, waste and end-of-life products, to facilities meeting quality treatment criteria.
- Introduce a progressive landfill ban on recyclable post-consumer goods and secure regular monitoring of end-of-waste export flows.
- Provide increased funding for circular economy innovation and R&D projects, in particular supporting the recycling of increasingly complex products.

3.2 Food & Drink Manufacturing

The food and drink manufacturing sector is the largest manufacturing sector in the EU, accounting for an annual turnover of € trillion 1.1. It is also the leader sector for employment, and constitutes 14% of household expenditures in the continent.[27]

Table 2: Structural business statistics of sector[28]

Number of companies	300,695
Number of Persons employed (million)	4,52
Average of employees	15
Average company turnover (million €)	3.15

The sector counts almost 300,000 companies with an average turnover of about € million 3. In terms of employment, more than 60% are employed in SMEs[29].

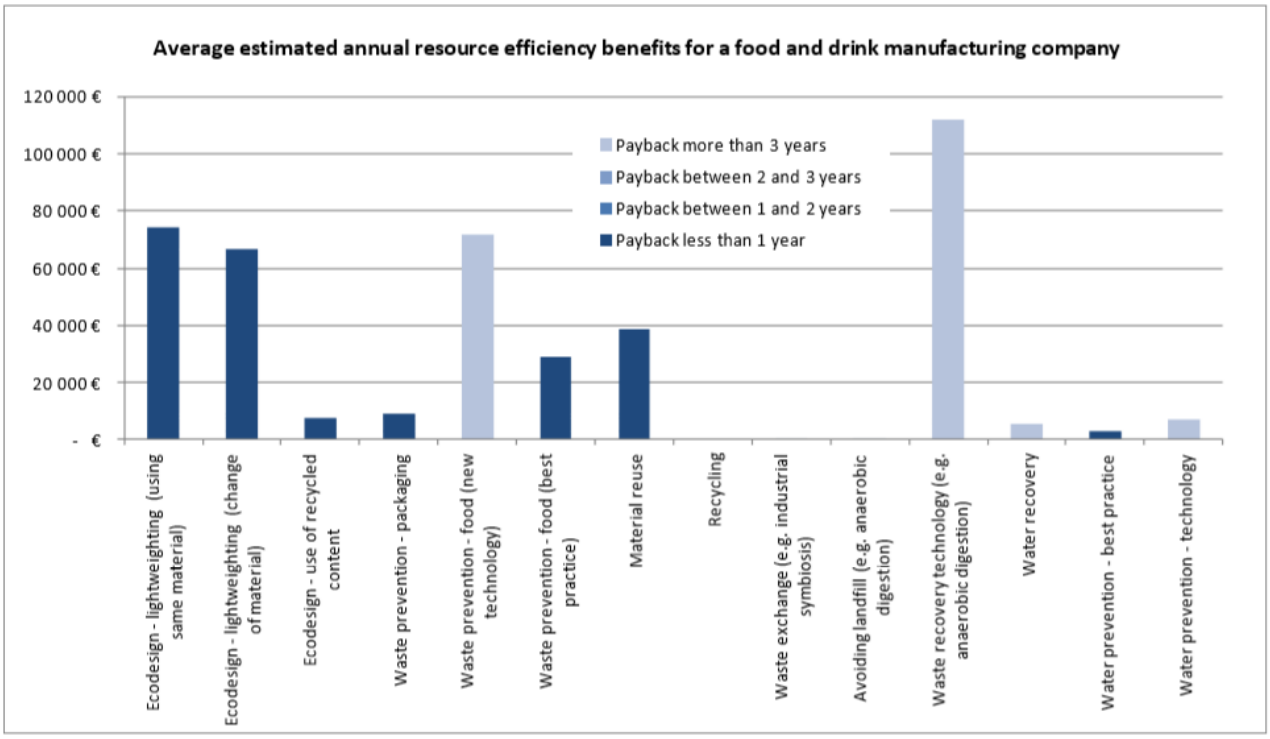
Significant amounts of inputs and waste are part of the operations in the sector. It is in fact estimated that over 2 million tons of agriculture and food produce are used every year to satisfy the production processes, while on average, 40 tons of food per company are wasted annually.[30] Furthermore, the food and beverage market is the largest consuming group of packaging,[31] hence very significant amount of packaging, in majority plastics,[32] are generated and wasted in the process.

Like for the metal manufacturers, resources represent a large percentage of the total costs also for companies in the food and drink sector. A study by McKinsey estimates that these costs account for around 35% of the entire turnover.[33] In the study by Amec and Bio Intelligence Service, annual average material, water, and waste management costs for a company amount to € million 1.27, or 41% of its annual turnover.[34]

The study by Amec and Bio Intelligence Service estimated that excluding initial investment costs, total annual gross benefits deriving from maximized resource efficiency measures, for an average food and drink company, amount to about € 424,000, or 13% of the turnover.[35] On the other hand, estimated costs needed to achieve those benefits account for about € billion 760 for the whole sector. Annual (gross) benefits for the sector in the 27 EU member states are € billion 64 – 118.

[27] FoodDrink Europe. (2017). *Data & Trends EU Food AND Drink Industry*. Retrieved the 22nd August 2018 from https://www.fooddrinkeurope.eu/publication/data-trends-of-the-european-food-and-drink-industry-2017/
[28] Eurostat. (2008,or latest year available data). European Business Statistics.
[29] FoodDrink Europe. (2017). *Data & Trends EU Food AND Drink Industry*. Retrieved the 22nd August 2018 from https://www.fooddrinkeurope.eu/publication/data-trends-of-the-european-food-and-drink-industry-2017/
[30] Amec & Bio Intelligence Service. (2013). *The Opportunities to Business of Improving Resource Efficiency*. pp 67. Retrieved July 20, 2018, from http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/report_opportunities.pdf
[31] https://www.packagingdigest.com/segment/food-beverage
[32] PlasticsEurope. (2016). *Plastics-The Facts*. Retrieved the 22nd August 2018 from https://www.plasticseurope.org/en/resources/publications/3-plastics-facts-2016
[33] McKinsey Global Institute. (2011). *Resource Revolution: Meeting the world's energy, materials, food and water needs*. Retrieved on August 20th 2018 from https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/resource-revolution
[34] Amec & Bio Intelligence Service. (2013). *The Opportunities to Business of Improving Resource Efficiency*. pp 69. Retrieved July 20, 2018, from http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/report_opportunities.pdf
[35] INDEM. pp 87.

Figure 3: Average annual benefits of resource efficiency measures for a food and drink manufacturer in the EU



In an order of the most financially interesting opportunities, the main resource efficiency measures in the sector identified in the analysis are represented by **waste recovery technologies** (such as digestion and degradation of organic waste), **waste prevention of food**, **design improvements** of packaging (eco-design by light weighting and material change), material reuse and waste prevention. Eco-design practices show an easier uptake due to a short payback period (less than one year), together with waste prevention and material reuse. However, the two measures representing some of the highest benefits are also the most expensive, with much longer payback periods (more than three years). Waste prevention measures for consumers, such as sell-by-date or portion size, haven't been considered in the study.

Annual benefits with a payback of less than one year account for € 227,000, while payback with more than three years' payback represent about € 230,000.

AB InBev- a more sustainable vision for 2025

AB InBev is the largest beer manufacturer in the world, owning more than 30 brands of beers. With its global outreach, the company has developed a plan to increase its resilience toward environmental challenges, such as water scarcity, global warming and resource depletion. The measures are part of the 2025 Sustainability Goals, which create a framework for the company's adaptability to global challenges, such as water scarcity, soil depletion, and global warming. As EUROCHAMBRES, we asked a couple of questions

to AB InBev in order to clarify what the Goals entail for the circular economy, and what the company believes these hold in terms of challenges and opportunities.

1. What are the reasons that lead Ab InBev to go toward a 100% returnable or recycled packaging? What is the expected percentage of returnable packaging and of recycled? What are the factors affecting these percentage differences?

   We're proud of what we've already accomplished in sustainability, but we know there's much more to be done. That's why our 2025 sustainability goals are our most ambitious yet. Our Goal: By 2025, 100% of our product will be in packaging that is returnable or made from majority recycled content. We are closing the loop to eliminate waste.
   We're constantly looking for ways to increase the recycled content in our packaging, to increase recycling rates around the world through the recovery and reuse of materials and through educating consumers on the importance of recycling, and to reduce the amount of material we use in our packaging.
   Our packaging sustainability journey accelerated in 2012 with a commitment to remove 100,000 metric tons of packaging material globally. We are proud that we were able to exceed this goal in 2016, removing 146,000 metric tons of material from our packaging while maintaining the quality our consumers expect. What's more, we've worked diligently in our breweries around the world to achieve an average 98% recycling rate.
   Our next challenge is to make sure all of our products are in packaging that is returnable or made from majority recycled content. We're just under half of the way there. To get there faster, we're working with multiple partners, including the Ellen MacArthur Foundation, the Closed Loop Fund, and the Glass Recycling Coalition, as well as our peers, our consumers, our vertical operations, local governments, and our suppliers.

2. What are the main conditions for a company like AB InBev to be able to convert its packaging model?

   If we want to convert our packaging model we need to focus on two things. First: try to avoid as much packaging as possible.
   Second: if package is needed, our product will be in packaging that is returnable or made from majority recycled content.

3. What are the main obstacles and benefits of this transition?

   To offer an alternative to disposable non-recyclable packaging, we need containers and packaging that are of high and stable quality. Food safety and quality are always key.
   Many of the new packaging innovations we have in our R&D pipeline are in advanced stages of development but, as with almost all new technologies, are high cost given their current stage of development. We're constantly initiating pilots on technologies that both prove their feasibility and potential for improved financials due to scale economies further down the line.
   That's why we, as the world's leading brewer, launched the 100+ Accelerator in August. We issued 10 challenges to start-ups around the world to help drive progress to the United Nations' Sustainable Development Goals (SDGs) and–AB InBev's 2025 Sustainability Goals. We received over 600 submissions from around the world in respect of all 10 challenges. After a rigorous review, 21 start-ups have been selected to join the first 100+ Accelerator class. Each of them receives up to $ 100,000 in support of our sustainability goals. This program is intended to provide the start-ups with the tools, resources and contacts they need to implement & scale these solutions across our businesses & partners. One of the selected start-ups makes natural, edible and hypo-compostable packaging from potato starch and saved grains from brewer's barley. We're dedicating time, money and in-house capability in fostering this innovation's path to greater success, making sure this patented product can become a unique, innovative and easy-to-use product for the food industry. Sustainability is not a competition— we believe in growing technologies like these for the benefit of consumers, peers and public institutions alike, for a better world.

4. What kind of actors or policies should be present in order to ease a smooth transition to circular packaging? What suggestions would you bring to European Institutions?

   The first exercise that the industry should undertake in close collaboration with the EU institutions is a review of the directives that prevent circular innovations. For example; as a result of an innovative process improvement to our brewing, we now brew alcohol-free beers just like we brew regular lagers — with a powerful body and the taste preserved, removing the alcohol content of the brew just before our no-alcohol beers are packaged. But **the alcohol** that we take out the beer through this unique dealcoholisation process **cannot be reused in the food industry due to a legacy European directive**. This is only one of the examples that prevent us from following through on circular economy opportunities that could close the loop. A review of some of the directives of a similar nature, developed before some innovations came alive, could help to make the circular economy more accessible.

   Moreover, the European institutions should make **sufficient funds available for innovation**. Innovations in Europe are our competitive advantage. Innovative ideas can only grow if there are sufficient funds and a good framework to grow.

3.3 Agriculture

In Europe there are approximately 10.5 million farms, together employing roughly 9.1 million people full-time, or 5.1% of the European workforce. 66% of European farms are smaller than 5 hectares (ha), while the average farm size, in 2013, was 16.1 ha. The average Standard Output (SO)[36] in 2013 was of 30,536.[37]

Farm numbers in Europe are continuously decreasing. In fact, between the period 2005-2013 the decline rate was of 2%. The observed reduction in farm numbers is an indication of farm size growth, in which very small holdings become part of larger farms.[38] On a parallel note, the European rural territory has to deal with other pressing issues, such as soil erosion, desertification, climate change, and eutrophication, affecting several areas of the continent for decades, and in many cases without successful results.[39] [40]

On one hand the agricultural sector in Europe is being revolutionized by fast digitalization developments, through Big Data analytics, robotics, and the Internet of Things (IoT), while on the other hand, a slow rapprochement to the principles and techniques of agroecology and conservation can be observed. [41] These changes enter within the vision of a circular economy, creating more efficient loops of resources.

The Ellen Mac Arthur Foundation, in the study conducted in 2017 'Achieving Growth Within', estimates a **€ billion 70 opportunity** to be invested by 2025 in the EU **to convert the agricultural food sector** into a fully circular system.[42] Following, a list of major disrupting innovations, techniques and opportunities in the industry is presented.

[36] SO: The average monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock.
[37] EC. (2016). *Facts and Figures on EU agriculture and the CAP.* Retrieved 4 October, 2018, from https://ec.europa.eu/agriculture/statistics/facts-and-figures_en
[38] IDEM.
[39] ECA. (2017). *Greening: A More Complex Income Support Scheme, Not Yet Environmentally Effective*. Retrieved December 12, 2018, from https://www.eca.europa.eu/Lists/ECADocuments/SR17_21/SR_GREENING_EN.pdf
[40] EC. (2018). EU Agricultural Outlook- For Markets and Income 2018-2030. Retrieved December 12, 2018 from https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/medium-term-outlook-2018-report_en.pdf
[41] Ellen Mac Arthur. (2017). *Achieving Growth Within*. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[42] IDEM. pp 30.

1) **Regenerative agriculture**: while being a growing concept within the industry, and a likely disruptor in the sector, regenerative agriculture's financial costs and benefits are still widely unknown. It is for this reason that the transition to more sustainable systems of this kind hasn't gained a wide uptake yet. A comprehensive study conducted by Rockström et al. found that the first 2-4 years, systems following regenerative techniques experience lower profits. Following this first period however, profits levels can increase by 200%[43]. Furthermore, a US study found that American corn farms following strict regenerative land methods earned 78% more than conventional corn farms.[44]

   The 'no-tilling' technique for cultivating crops is one of the main practices of this concept of agriculture. Combining no-tilling with precision farming, farmers can achieve a 75% reduction on machinery and input costs for farms.[45] Additionally, in the ''Most Comprehensive Plan to Reverse Global Warming' published in 2017, it is calculated that by 2050, regenerative agriculture alone could offer global net operational savings of € trillion 1.7[46], with net implementation costs of € billion 50.6.[47] In the 'Achieving Growth Within' study, the Ellen Mac Arthur Foundation calculates that **with an investment of € billion 15** between 2016-2025 on regenerative agriculture systems in the EU, starting from 2030 **annual economic benefits** –mainly deriving from reduced pesticide and fertiliser costs, as well as GHG emission costs- **could amount to € billion 35**.[48]

2) **Precision farming**: this concept alone, which was previously mentioned, utilizes digital technology to increase the efficiency in the use of pesticides and all inputs for farming practices (e.g.: fertilizing, irrigation, pesticides and fungicides), represents an opportunity of **saving up to 20-30% of agricultural inputs**.[49]

3) **New protein sources**: € billion 2 by 2025 is the investment opportunity in this new market that is expected to increase the protein availability in our diets, while dramatically increase the resource efficiency in the production. **€ billion 40 in benefits** are estimated to be created between 2016-2030, through reduction in costs for farm inputs, as well as a reduction in GHG emissions. [50]Examples of these new products are insects, hemp, seaweeds, microgreens, mycoproteins - mushroom derived proteins-, and plant-based "meats". By 2054, alternative proteins are estimated to take up to a third of the proteins' market.[51]

4) **Organic waste**: large investments are expected to be made to develop infrastructure to increase nutrient and energy recovery from organic waste. The Ellen Mac Arthur Foundation estimates that € billion 10 would be needed to make European organic waste fully circular. If done so, **€ billion 2**

[43] J. Rockström et al. (2015). *Planetary Boundaries: Guiding Human Development on a Changing Planet*. Science.
[44] LaCanne. CE, Lundgren JG. (2018). *Regenerative agriculture: merging farming and natural resource conservation profitably*. PeerJ 6:e4428https://doi.org/10.7717/peerj.4428
[45] European Parliament. (2014). *Precision Agriculture: an Opportunity for EU Farmers – Potential Support with the CAP 2014-2020*. Retrieved August 5, 2018, from http://www.europarl.europa.eu/RegData/etudes/note/join/2014/529049/IPOL-AGRI_NT%282014%29529049_EN.pdf
[46] This figure includes environmental and societal externalities; and converted from USD with 2017 conversion ratio.
[47] Hawken, P. (2017). *Drawdown: The most comprehensive plan ever proposed to reverse global warming*. New York, New York: Penguin Books.
[48] Ellen Mac Arthur. (2017). *Achieving Growth Within*. Pp 82. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[49] J. Rockström et al. (2015). *Planetary Boundaries: Guiding Human Development on a Changing Planet*. pp 26. Science.
[50] Ellen Mac Arthur. (2017). *Achieving Growth Within*. Pp 106. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[51] LuxResearch. (2015). *Alternative Proteins to Claim a Third of the Market by 2054* [Web post]. Retrieved August 22, 2018, from http://www.luxresearchinc.com/news-and-events/press-releases/read/alternative-proteins-claim-third-market-2054

would result as benefits, mainly in value creation from nutrients recovery, and carbon dioxide reduction.[52]

Waste has the opportunity to be seen as a source of feedstock for animals, methane from anaerobic digestion, or fertilizer- as compost. Because of the EU's regulation on fertilizers, which creates a single market for fertilizers, 120,000 new jobs are expected to be created.[53] On the other hand, because of the same Regulation, another study from 2014 reports that compliance costs are expected to represent 10% of production costs for compost producers, an impact that is predicted to particularly affect SMEs competitiveness.[54]

5) **Vertical and urban farming**: considered another great possible disruptor in the sector, since their introduction vertical farms, which include hydroponic, aquaponic and aeroponic systems, have so far experienced a slow uptake due to large capitals needed on the initial phase of the operations.[55] By creating urban vertical farms, however, the proximity to buyers can lead to up to 60% of overall savings for the producers.[56] Urban farms represent a great opportunity for small producers' resilience, short loops of resources and food security. While the concept is still at its infancy, there are studies such as the one by W. Lorleberg, which indicate the significant economic potential of urban agriculture, if executed at 25 or 50% of total urban areas.[57] In cities like Vancouver, Canada, SPIN -Small Plot Intensive- farming is able to annually gross over € 50,000 from a 0.2 hectare land plot.[58]

Società Agricola Case Levi - Biogas for management of livestock waste

Case Levi is an agricultural enterprise located near Treviso, in the Veneto region, and counting 750 units of cattle, 250ha of sown crops (e.g.: corn, soy), and 5ha of grapevines. In total, the business activity brings in an annual turnover of € million 3.

[52] Ellen Mac Arthur. (2017). *Achieving Growth Within*. Pp 92. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[53] EC. (2016). Proposal for a Regulation on the making available on the market of CE marked fertilising products and amending Regulations. Retrieved August 20, 2018, from http://ec.europa.eu/DocsRoom/documents/15949
[54] Wageningen. (2014). *Competitiveness proofing- fertilising materials*. [page 13] Retrieved August 1, 2018, from https://publications.europa.eu/en/publication-detail/-/publication/cc21c040-bf2f-42e1-85e7-f230f3b507b6/language-en
[55] Al-Kodmany, K. (2018). *The Vertical Farm: A Review of Developments and Implications for the Vertical City*. Retrieved August 20, 2018, from file:///C:/Users/circular.economy/Downloads/buildings-08-00024-v2.pdf
[56] Al-Kodmany, K. (2016). *Sustainable Tall Buildings: Cases from the Global South*. Int. J. Archit. Res. 52–66.
[57] W. Lorleberg. (2016). *Urban agriculture has an economic dimension.* Chapter 3.
[58] Dorward C., Mullinix K., Schutzbank M. (2013). *The Urban Farming Guidebook*. Chapter: Six, Publisher: EcoDesign Resource Society, pp.43.

In order to reduce the legal and economic pressures caused by the livestock effluents, in 2012 Case Levi decides to invest in a € million 2.5 biogas plant, which currently produces 500Kw of electricity and rich composted organic matter to spread in the fields or sell to neighbouring farms.

1) The experienced benefits of the biogas plant:

-No bad smells or insects
-Production of rich compost in a 3-4 month period
-High interest from other farms to purchase the organic matter resulting from the process
-1/3 of the overall turnover deriving from the plant

2) What are the challenges observed or improvements that are needed:

- Subsidies integrated in the selling of electricity have diminished in the years due to high speculation
- Bureaucracy is very complicated
- The directive on waste on the regional level has created even further complications: while food by-products are allowed to be used in biogas plants at the European level, due to legislative discrepancies this is not allowed in many municipalities in Italy.
- Biomethane is actually considered a new and upgraded version of biogas plants. Energy efficiency can in fact increase from a rough maximum of 42% from biogas, to 50-60% for biomethane.[59] However, legislative and economic incentives for this technology still need to reach the Italian territory.

3.4 Hospitality and Food services

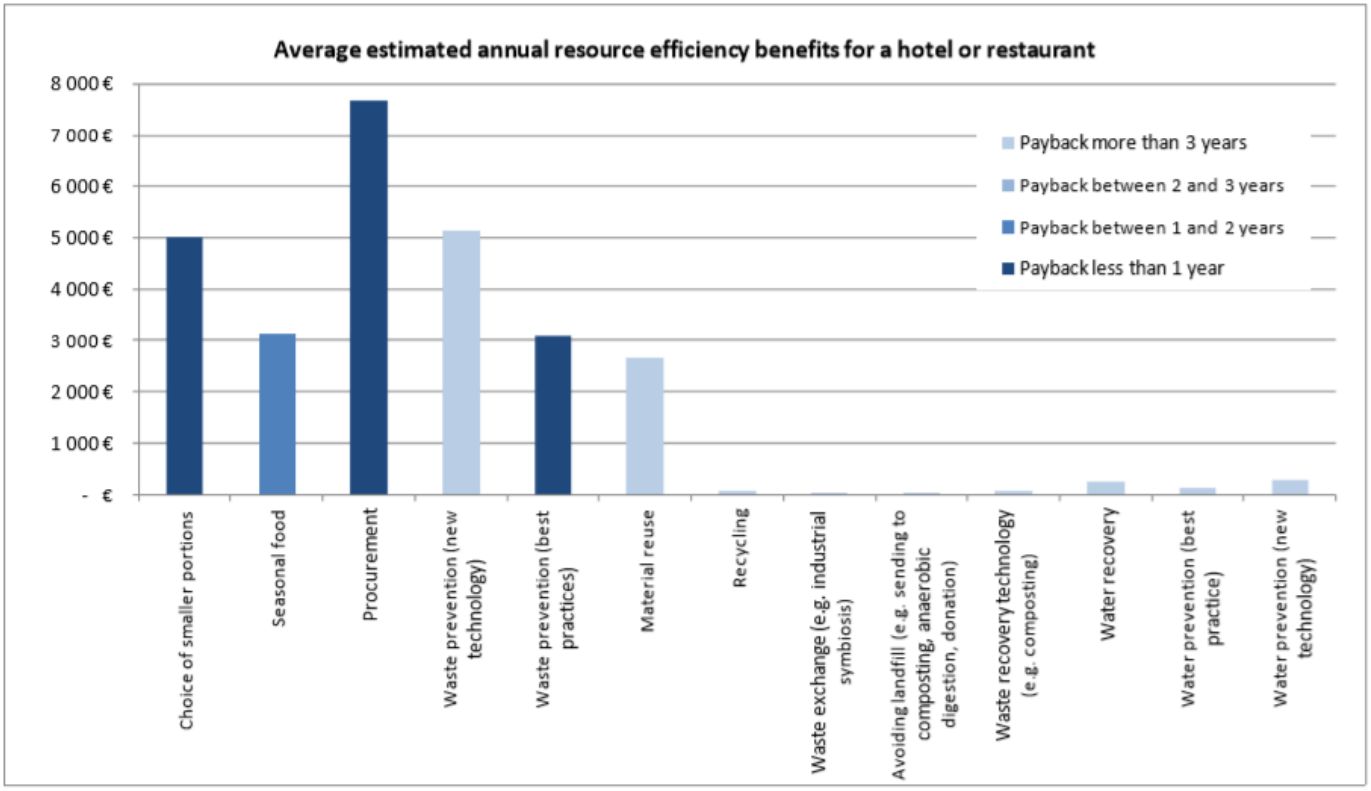
The hospitality and food services sector comprises 1.9 million enterprises, which together employ more than 11 million people. The average annual turnover per company in the sector in 2015 -latest data available- was of around € 582,467.[60]

According to the previously used study by Amec and Bio Intelligence Service, hotel and restaurants operate with resource costs (material, water, and waste management) accounting to € 82,747, or what prior to 2014 -year of the study- was 31% of the average total costs.

Like previously mentioned, average investment costs weren't calculated for the report, but only the sector's total investment potential for resource efficiency. With a total sector's investment rounded to € billion 100, it is forecasted that companies will receive average net benefits of € 27,500, equal to 10% of the average turnover in the year previous to the study. The total annual benefit for the sector would be € billion 64-118.[61]

[59] Data provided during the interview.
[60] Eurostat. (2015). Accommodation and Food Service Activities (NACE Section I)- data.
[61] Amec & Bio Intelligence Service. (2013). *The Opportunities to Business of Improving Resource Efficiency*. pp IV. Retrieved July 20, 2018, from http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/report_opportunities.pdf

Figure 4: The average annual benefits of resource efficiency measures for a hotel or restaurant in the EU



Breaking down investment opportunities in the hospitality and food services sector we can observe how most of the major measures that can be undertaken for resource efficiency are considerably low cost and with short payback periods. The top three measures account for about 65% of the potential benefit: procurement, accounting for 28%, waste prevention through new technologies-19%-, and smaller portions -18%-.

Martin's Hotels- a vision for circular hospitality

MARTIN'S HOTELS
TOMORROW NEEDS TODAY

Martin's Hotels is a hospitality service based in Belgium with hotels located throughout the country's territory. The Environmental Management System **(EMAS)** is implemented and applied according to the requirements and guidelines of the ISO 14001 and EMAS standards. Martin's Hotels applies the circular economy model to its purchasing, waste and during the renovations it undertakes at the various sites.

The company has created a **sustainable purchasing charter**, a policy that implies the need to take environmental performance and costs into account throughout the life cycle of the goods and services acquired, including planning, purchasing, use and recycling at the end of life . The goal is to favour, in line

with the economic constraints and the contractual agreements, the purchase of locally sourced food and water, i.e. bought within a radius of no more than 300 kilometres.

Furthermore**,** Martin's Hotels introduced the **Supplier Code of Conduct** to influence its external stakeholders to increase their environmental standards. With more than 80 recurring suppliers and a large volume of purchases, it is indeed essential to define this kind of target.

Some of the initiatives taken are summarized here:

- Give preference to local, natural, recycled/recyclable and seasonal products
- Encourage suppliers to adhere to their Code of Conduct
- Minimize the flow of incoming waste and recycle as much as possible the waste inherent to the hotel business (67% of maintenance products are rechargeable, eco-labelled or in concentrated doses, which reduces the volume of waste)
- Work exclusively with authorized suppliers in the 3 regions and comply 100% with the technical-legal requirements in terms of safety, compliance and maintenance of technical equipment
- Integration of **environmental performance** in the analysis of new supplier offers
- Integration of environmental performance into the analysis of tenders
- Purchase of 100% **green electricity**
- 100% of paper FSC certified or with EU Eco-label
- Fitness equipment, company cars, computer equipment, coffee machines (Rombouts) in rooms, seminars, restaurants and bars are under a **leasing** or on loan for use contract.
- **Choice of providers** with strong environmental policies (Vranken pommery, Spadel, Raypath)
- Easily **replaceable** and **recyclable** carpets (Desso)
- Charging station for electric cars
- Limitation of packaging in rooms and common areas.

1) What is the competitive advantage of EMAS certification :
- Promote the sense of belonging and pride of working at Martin's Hotels
- Give a guideline to the management
- Establishment of the structures and procedures of follow-up to concretize the commitment
- Staff participation at all levels guaranteed by the system and procedures
- Follow-up of new technologies and legislation to be at the forefront of the change
- Incentive for product research, technical installations and innovative services
- Legitimacy of choices and decisions of companies concerning investments in technical-legal terms
- Communication lever
- Official recognition of the commitment: credibility of the approach

2) What are the recommendations and challenges?
- Access to supplier data
- Customer expectations of a hotel service standard
- Environmental standards created with the industrial sector in mind that are hard to bear for a service sector
- Investment challenges
- 3 distinct legislations - difficulty to find suppliers who can answer and have the approval of the 3 regions

3.5 Mobility

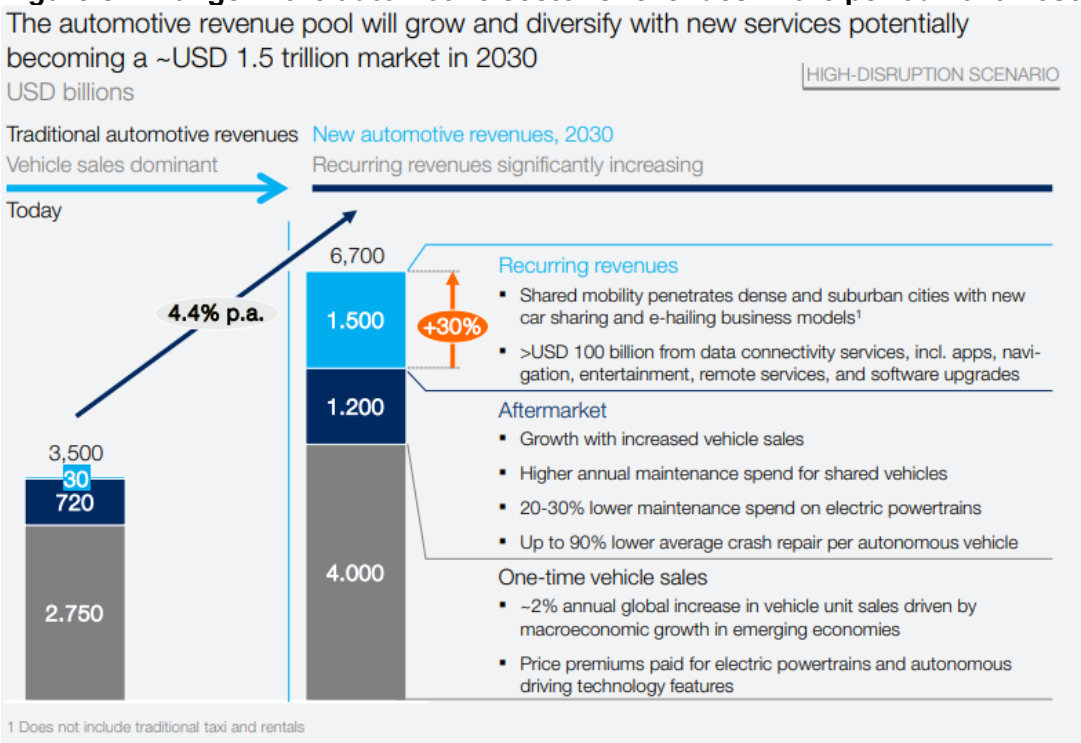
The mobility sector, including the transport and storage services sectors, employs more than 11 million people in Europe. This represents 5.2% of total jobs. The sector also occupies 13% of household

expenditure, and in 2015, had a Gross Value Added (GVA) of € billion 651, accounting for 5% of total EU-28 GVA.[62]

For the mobility sector, as for other sectors in this report, the economic analysis appeared to be limited to only certain figures. However, this section is able to provide some main figures in terms of cost savings, societal costs avoidance, and investment and new business opportunities for the automotive industry.
One of the main opportunities in the sector is represented by the integration of shared vehicles in the automotive market and public transport.

By 2030, building an **electric shared vehicles fleet**, associated with public transportation services, and integrated in a digitalized system, could bring up to **€ billion 175 in annual societal cost savings** (e.g. congestion, increase of urban spaces). This would be achieved with an estimated investment of € billion 100 by 2025.[63] It might appear counterintuitive, but even with the prediction of 1 out of 10 cars being shared by 2030, the automotive market is expected to see its revenues growing considerably. Globally, the automotive industry will see revenues rising up to 30%, or € trillion 1.36.[64] [65]

Figure 5: Change in the automotive sector's revenues in the period 2016-2030[66]



This important disruption in sales is expected mainly thanks to a large increase in sales in emerging markets. The increase in revenues therefore is expected to increase by 4.4% per annum, while the already important sales rate increase is expected to lower down to +2% annually. Additionally, the shared vehicles market is

[62] EC. (2017). *Statistical Pocketbook 2017*. Retrieved August 24, 2018, from https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2017_en
[63] Ellen Mac Arthur. (2017). *Achieving Growth Within*. pp 56. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[64] Data converted from USD 2016 conversion ratio.
[65] McKinsey & Company. (2016). *Automotive Revolution – Perspective Towards 2030*. Retrieved August 12, 2018, from https://www.mckinsey.com/~/media/mckinsey/industries/high%20tech/our%20insights/disruptive%20trends%20that%20will%20transform%20the%20auto%20industry/auto%202030%20report%20jan%202016.ashx
[66] IDEM.

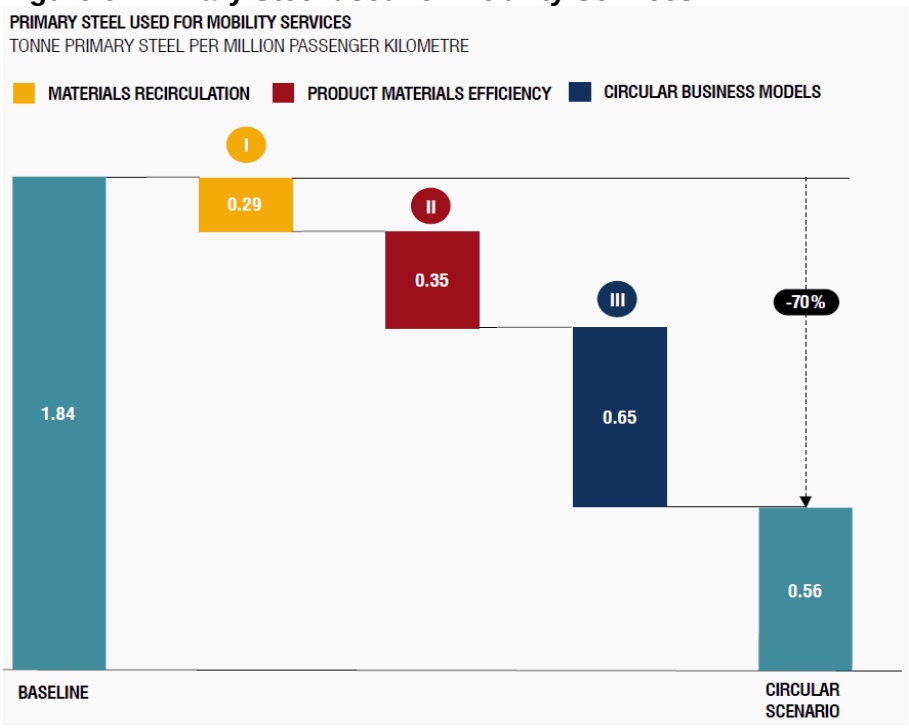
expected to grow every year by 40%, and by 2030, it is predicted it will represent 22% of the total revenues in the sector.[67]

Opportunities are seen also in developing technologies that enable the use of **durable** and **high-value materials**, therefore allowing for end-of-life looping processes. The study "Growth Within"[68] estimates that this represents a € billion 35 opportunity, for investors that are willing, and able, to invest large sums of capital in R&D. **Benefits would amount to € billion 75 per year by 2030**, mainly by reduced costs of materials and a smaller vehicle fleet.

Remanufacturing, which is understood as the series of steps undertaken on end-of-life products to bring them back to their original -or even improved- performances, represents an important cost saving opportunity for companies operating in the mobility sector. The Ellen Mac Arthur Foundation ,together with SYSTEMIQ, estimated that by investing € billion 1 spread over the period 2016-2025, **the EU could obtain € billion 30 benefits by the year 2030**.[69] Mainly through reduction of costs of manufacturing.

Steel in the Mobility's sector- a financial opportunity

Figure 6: Primary Steel used for Mobility Services



The automotive sector consumes 20% of the total demand of steel in the EU, and is only second to the construction sector. Being 100% recyclable, steel represents an important opportunity to both cut down on unnecessary costs, and make the production chain more resource efficient. Additionally, steel is for the most part imported from third countries. Converting the current linear system represents an opportunity for the EU to become more independent and less sensitive to market price volatility. Through material recycling (I), material efficiency improvements -like process losses- (II), usage intensity increase -through, for example, higher rates of shared vehicles- (III), EU mobility sector could **cut down** on **70%** of their steel **consumption**.
(This data depicts changes in consumption for downstream producers, such as the automotive sector, and not up-stream producers, like metal manufacturers)

Source: MaterialEconomics [70]

In a broader attempt to quantify cost saving opportunities, in one of its latest reports the Ellen Mac

[67] IDEM. pp 6.
[68] Ellen Mac Arthur. (2015). *Growth Within: a Circular Economy Vision for a Competitive Europe*. pp 63. Retrieved July 25, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf
[69] Ellen Mac Arthur. (2017). *Achieving Growth Within*. pp 74. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[70] MaterialEconomics. (2017). *The Circular Economy a Powerful Force for Climate Mitigation.* Retrieved September 15, 2018, from https://www.euractiv.com/wp-content/uploads/sites/2/2018/06/MATERIAL-ECONOMICS-Circular-Economy-Review-draft.pdf

Arthur Foundation estimates the cost savings that the sector would achieve by adopting a full circular scenario.

Figure 7: Circular mobility opportunity- 2030 Scenarios[71]

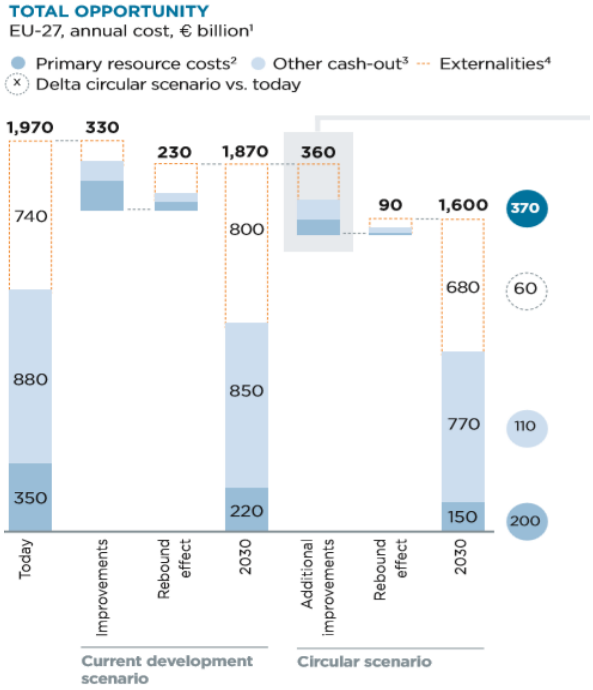


Figure 7 portrays three different case scenarios: today, current development, and circular scenario. The modelling was executed in order to -vertically- compile the total amount of primary resource costs, other cash outs -such as household expenditure on vehicles, insurance, maintenance, fuel and parking, governmental negative externalities related to pollution, noise, and accidents– and externalities projected in a time-lapse between 2015-2030.
If we exclude externalities, which comprise social and environmental costs, the sector has the potential to save up to € billion 310. Including externalities, the cost savings reach € billion 370- the calculations also include the rebound effect[72] of such measures-.

[71] Ellen Mac Arthur. (2015). *Growth Within: a Circular Economy Vision for a Competitive Europe*. pp 63. Retrieved July 25, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf

[72] Rebound effect: phenomenon in which lower prices lead to (unexpected) higher consumption, therefore diminishing the impact reduction effect of said initiative.

XYT- modular, electric and sharable vehicles

XYT is an automotive start-up based in Paris, and currently working on launching some of the first modular, upgradable and electric utility urban vehicles in Europe. The models currently on their way to be introduced are a multi-use truck for deliveries, a taxi, and a vehicle for individual mobility -that in the future could be used for shared rides as well-.

The innovation brought by XYT is through the design of its vehicles. Composed by only 600 highly durable components, they can be easily replaced or repaired following the "Lego" principle. Additionally, the overall weight of the models is half of conventional vehicles.

Although the returns on investment are expected to be longer, the company believes in the economic sustainability of the concept, based on modularity and durable vehicles, as it believes that the initial cost of the vehicles -due to the battery costs and product quality- will be compensated by the higher life-span of the product and its saved costs in maintenance and repair.

The company is planning to launch its first 100 vehicles in 2019 in the city of Paris as a pilot project and targets to expand at the European scale on a city by city basis. To accelerate its development, XYT is currently raising funds and building strategic partnerships with long-term leasing companies. In addition, XYT mentions that **there is no real EU certification framework** to integrate vehicle upgrades & evolutions, everything being defined for brand new cars. Such considerations could also help the development of such modular & circular industrial models.

3.6 Construction

The construction sector is a vital backbone of the European economy. The sector includes 3 million enterprises in total employing 18 million people. It contributes to 9% of the EU's GDP -16% when considering also real estate activities- and 5% of GVA.[73]

The sector is being disrupted by an important growth in shared offices and residential space, and net-zero energy buildings. 3D printing technologies are also being scaled up, together with modular building techniques.

Investments within the construction sector in the EU represent a great opportunity. In "Achieving Growth from Within", the Ellen Mac Arthur Foundation, together with SUN Institute and Systemiq, estimate that by investing € billion 107 between 2016-2025, Europe would be able to close the loop of materials in the

[73] Eurostat. (2015). Construction, building and civil engineering data.

construction sector and attain € billion 150 of benefits between the period 2016-2030, benefits of which details are now clarified. Firstly, shifting to **designing and producing circular buildings**, hence made of modular pieces, as well as using renewable and recyclable materials, would require an investment of € billion 105, which by 2030 would lead to € billion 135 of reduced repair and maintenance, as well as utility costs. Secondly, in order to make **recyclability and reuse** prosper in the sector of construction, € billion 2 need to be invested for the creation of waste recovery plants. Doing so would bring € billion 15 in cost savings, mainly in material and waste costs.[74] Additionally, modular and industrial processes alone could lower costs by 50% compared to onsite constructed buildings.[75]

Although these developments represent part of the solution, a system needs to be implemented to also include end-of-life materials -therefore boosting recycling and reuse-, which represent a great challenge in the sector, for both its environmental footprint and financial impact.[76] Collaborations need to be created between producers in order to set up end-of-use processing of materials. On a parallel note, the challenge could be overcome by companies by implementing performance or service-based business models, where buildings are leased or rented.

There is a large discrepancy in the recycling of construction materials in the Eurozone. About 54% of the total waste in the sector is being landfilled, while in some countries this amounts to only 6%. [77] For this reason the investment opportunity between 2016-2025 in the **recycling and re-use** business for these materials remains huge, estimated at € billion 2.[78] Benefits are calculated to amount to € billion 15 by 2030, due to reduced material costs and waste. Furthermore, a study by Arup suggests that designing a material like steel for reuse, could generate high potential value for building owners, with likely savings of 6–27% for a warehouse, 9–43% for an office, and 2–10% for a whole building, as well as up to 25% savings on material costs.[79]

[74] Ellen Mac Arthur Foundation. (2017). Achieving Growth Within. pp. 114-127. Retrieved August 14, 2018 from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[75] Ellen Mac Arthur. (2015). *Growth Within: a Circular Economy Vision for a Competitive Europe*. pp 63. Retrieved July 25, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf
[76] Ellen Mac Arthur. (2017). *Achieving Growth Within*. pp 32. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[77] Ellen Mac Arthur. (2015). *Growth Within: a Circular Economy Vision for a Competitive Europe*. pp 82. Retrieved July 25, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf
[78] Ellen Mac Arthur. (2017). *Achieving Growth Within*. pp 36. Retrieved July 23 ,2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
[79] Arup. (2016). *The Circular Economy in the Built Environment*. Retrieved August 1, 2018, from file:///C:/Users/circular.economy/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/Circular-Economy-in-the-Built-Environment-270916.pdf

'Montagne du Parc 3'- A new circular headquarters in the heart of Brussels

Who?

In collaboration with the General Contractor EIFFAGE, the JV Baumschlager Eeberle Styfhals & Partners Jaspers-Eyers Architects and other partners (Seco, Vinçotte, Ramboll, …), BNP Paribas Fortis is building its new headquarters with a circular mindset, five minutes from the Grand Place of Brussels. The building will be the main building of the cluster Uptown for all Brussels' BNP Paribas Fortis employees, and within its 103,000 m², will also host a conference centre, a business hub, an underground parking for bikes and cars, commercial shops and a restaurant in a multi-tenant lay-out.

Why circular?

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1. Energy and resource efficient: BNP Paribas Fortis aims to obtain the BREEAM "Excellent" certification. The maximum energy consumption cap for the building is set at 15Kwh/m²/year for both cooling and heating. Thanks to 1300 m² of solar panels, an underground +/- 14,000 m³ Seasonal Thermal Energy Storage tank filled with -aquifer- water acting as a 'heat exchanger and regulator' with the top floors, the building consumes 7 times less energy than the previous one. This results into highly reduced maintenance and energy costs for the company.

2. Flexible & modular: designed with principles of open space and New Way Of Working concept, the new building will have the same size as the old in terms of m², but will accommodate 4.500 workstations, which will result in 70% more than the previous capacity. This is made possible by creating co-working and flexible spaces that will make the building more efficient in terms of space-use, but also dynamic and communal.

3. Full loop of materials: due to regional legal obligations, a majority of construction and demolition materials can no long enter in landfills in the Belgian territory. However, the recycling approach was larger than the legal aspects. That is why 98.2% of materials -steel, concrete, glass, wood, plastics, electric cables, etc..- of the old building were carefully disassembled and removed to then be sold to various recycling facilities spread around the Belgian and European territory.

   According to BNP Paribas Fortis, the high rate of recycling and re-use of materials was made possible also thanks to a strong effort of the company and its collaborators to find a second life for

materials. A good example are office desks and chairs, that were openly sold to employees and ceilings, light walls, fixed furniture to other stakeholders during the demolition of the building. As discussed in the following section, the recycling of construction materials represents both a challenge but a great opportunity for local businesses.

Cost?

The cost impact of such sustainable and circular actions takes into account very different factors: standard and legal obligations, market opportunities, etc. The cost of all works, including circular actions, for the new headquarter is hardly restricted to a fixed budget defined in relation with the bank requirements. These requirements, at a high level view, are there to support a global approach: architectural, urbanistic, technical and environmental in order to create a sustainable building, “a building that lasts”.

A conversation with the demolition company

De Meuter was the company involved in the demolition of the building and responsible for the disassembling and shipping of construction and demolition waste (CDW) to the recycling plants. From the interview conducted with one of the company’s managers, some major observations can be presented.

a) Regional and national laws banning CDW from landfills are a first necessary step for the integration of a circular model in the sector.

b) Recycled materials represent a huge business opportunity: the price difference between raw materials and recycled fluctuates considerably with time, triggered by demand-supply pressures on the global market. Recycled materials , however, remain extensively cheaper. Concrete for example, which at the moment is mostly downcycled to create, inter alia, the foundations of buildings, can be sold as an alternative to aggregates for up to 4 times less their price. Aggregates are the major ingredient for the concrete mix, and when originating from recycled concrete, cost 6€/ton compared to the 20-24 €/ton for new concrete aggregates. Recycled pressed wood, although difficult to disassemble for re-use, can be 30% cheaper than new pressed wood. Steel undergoes high price fluctuations, but the iron base can be 4-5 times cheaper when originating from recycled materials.[80]

c) Disassembling old buildings is often times difficult: while concrete and steel are relatively easy to break apart and ‘disassemble’ from the mountain of debris in a demolition site and subsequently recycled, other materials such as carpets, wood or plastics must undergo a much stricter scrutiny and can be difficult and often times impossible to be accepted for recycling or re-use. This remains a large time-consuming and economically inefficient obstacle, which could be in part resolved by more accurate design and use of modular structures and products.

[80] Prices were gathered during the interview and are only representative for the disassembling time period, due to high price volatility.

d) The recycling industry is still too fragmented for an efficient loop of materials: platforms such as Opalis have been put in place exactly to provide a more fluid circulation of CDW within national borders. Such platforms are an example on how a transparent network of stakeholders and actors can make up for the information gap in the market. Because of the lack of a mature recycling market however, it still remains hard for demolition companies to dispose of some materials, or to avoid paying fees for their discard. For the Montagne de Parc project, glass had to be sent to facilities in Poland due to high discharge fee costs in local plants. In such occasions, a circular model is not only energy inefficient, but also economically unreliable.

e) Higher interest from builders and customers is needed for higher uptake of recycled materials: our interviewee stressed on the fact that it is the end-consumer, the demand, which can pull the reins to redirect them toward more circular flows of materials. Trends oriented toward modern designs dramatically undervalue the massive volume of CDW originating from old and demolished buildings. An evaluation of this issue could lead to a reconsideration and revaluation of older interiors. Obligations on recycled material usage on construction companies, for example, could create more efficient flows of materials' circulation.

3.7 Plastics

The European Union is the second biggest producer of plastic materials in the world -19%- after China, which alone produces 29% of the total production. The plastics industry in the EU is represented by 60,000 companies employing over 1.5 million people. In 2017, its total turnover was above € billion 350.[81]

Total recycling rates in the European Union are some of the most advanced in the world, but are still considered suboptimal by some. The EU in 2016 was recycling 31% of its discarded plastics, while sending 27% to landfills and 42% to incineration.[82] As shown in a research by Eunomia however, recycling percentages might actually be slightly lower due to discrepancies in the way that recycling rates are nationally defined.[83]

It is therefore clear that the production and discard of plastics is still for a great part not integrated in a circular flow of materials. The study on the New Plastics Economy by the Ellen Mac Arthur Foundation calculated that 95% of plastic packaging material value, between € billion 70-105 , is lost to the economy after the first use.[84] Seen differently, this loss can be seen as an opportunity: collectors and recyclers of plastic have the potential of keeping the value within the production chain, therefore transforming this € billion 70-105 loss into profit.

Furthermore, a report by the UN Environment Programme (UNEP) and the Plastics Disclosure Project, based on research conducted by Trucost, estimated the total natural capital cost of plastics in the consumer

[81] PlasticsEurope. (2018). *Annual Report PlasticsEurope 2018*. Retrieved August 25, 2018, from file:///C:/Users/circular.economy/Downloads/AnnualReport2018_PlasticsEurope_Web.pdf
[82] PlasticsEurope. (2017). *Plastics – the Facts 2017*. Retrieved August 26, 2018, from https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf
[83] Eunomia. (2016). *Recycling-Who Really Leads the World?*. Retrieved September 3, 2018, from http://www.eunomia.co.uk/reports-tools/recycling-who-really-leads-the-world/
[84] Ellen Mac Arthur Foundation. (2016). *The New Plastics Economy- Rethinking the Future of Plastics*. Page 17. Retrieved August 2, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_Pages.pdf

goods industry at € billion 56, of which € billion 30 billion[85] -53%- was related to plastic packaging, a sum which exceeds the profit pool of the plastic packaging industry.[86]

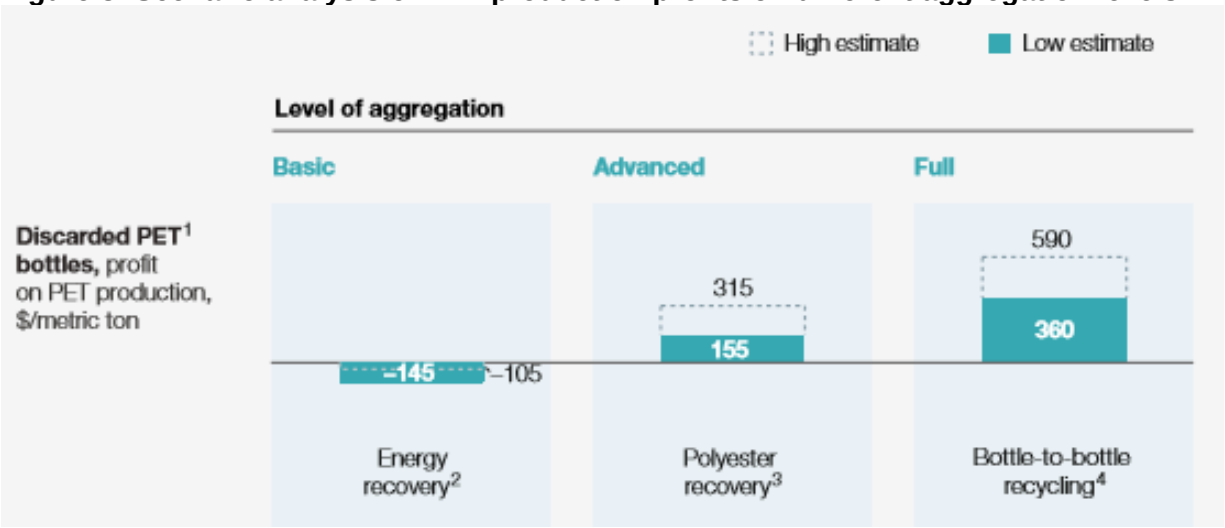
There are a series of developments that need to be considered for a proper conversion of the current linear system in the sector.

1) An effective after-use economy must be implemented.

Recycling is one of the basic opportunities of the after-use market: in the study by the United Nations,[87] a survey was conducted in collaboration with some of the 100 largest publicly-listed companies in the world to extrapolate the financial benefits deriving from recycling and other good management practices for plastics. Although with large limitations, the report found that on average, consumer goods companies following these practices were able to save € billion 3 per year[88].

In a more practical illustration, offered in a report by Mc Kinsey,[89] it was estimated that the recovery of PET bottles represents a great business opportunity for PET producers worldwide. Drawing the scenario analysis for three aggregation levels -Figure 8-, the study found that the different recycling schemes can bring between $155-590 per ton of material.

Figure 8: Scenario analysis of PET production profits on different aggregation levels[90]



On the other hand, a study conducted by the World Economic Forum[91] places the overall global potential of scaling up high-quality plastics recycling -through harmonised collection and sorting systems- to a profit of 100-150 $/ton.

2) Design as a cost-saving and resource-efficiency measure

[85] Data converted from USD 2014 conversion ratio.
[86] UN. (2014). *Valuing Plastic: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry*. Retrieved July 30, 2018, from http://wedocs.unep.org/handle/20.500.11822/9238
[87] IDEM. pp 13.
[88] Data obtained from USD 2014 conversion ratio.
[89] Mc Kinsey. (2016). *The Circular Economy: Moving from Theory to Practice*. Retrieved August 12 , 2018, from https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability%20and%20Resource%20Productivity/Our%20Insights/The%20circular%20economy%20Moving%20from%20theory%20to%20practice/The%20circular%20economy%20Moving%20from%20theory%20to%20practice.ashx
[90] IDEM, pp. 13.
[91] World Economic Forum. (2017). *The New Plastics Economy- catalysing Action*. pp. 23. Retrieved August 29, 2018, from http://www3.weforum.org/docs/WEF_NEWPLASTICSECONOMY_2017.pdf

Packaging **design** represents another very important opportunity for both companies and the environment. Carefully re-thinking the format design -e.g. glues, inks, shape of packaging-, polymer choice, pigment choice, and additive choice -e.g. to tackle discoloration-, could bring profits up to 90-140 $/ton.[92]
The implementation of both measures, recycling and design, can generate a total value improvement of 190 $/ton for the plastics industry, from an average net cost between -170 and -250 $/ton to a net cost of 20-40 $/ton.[93]

3) Reusable and compostable packaging as disruptors in the sector

Other certain disruptors in the industry are **reusable** and **compostable packaging**. On January 2018, following the New Plastics Economy initiative, the Ellen Mac Arthur Foundation shared the list of major packaging and retailer companies that will be taking 100% reusable, recyclable, or compostable packaging commitments by 2025. The brands currently in the list are 11, and include important names such as: The Coca-Cola Company, Unilever, Mars, L'Oréal, and Walmart.[94]

Re-use packaging schemes have received different critiques. On one hand, a considerably old study commissioned by the European Commission in 1999 on reuse and refill schemes, found the business opportunity to be five times more expensive for companies than the conventional linear model.[95] On the other hand, newly developed refillable bottles and ingredients' models such as the ones presented by brands like Splosh, or Replenish, have proven that companies can attain 25-50% packaging cost savings, and 85-95% transportation cost savings. Applied to all beauty and personal care, as well as house cleaning products, this model would make companies save up to $ billion 8 in packaging savings.[96]

4) Reduction of plastic leakages in the environment

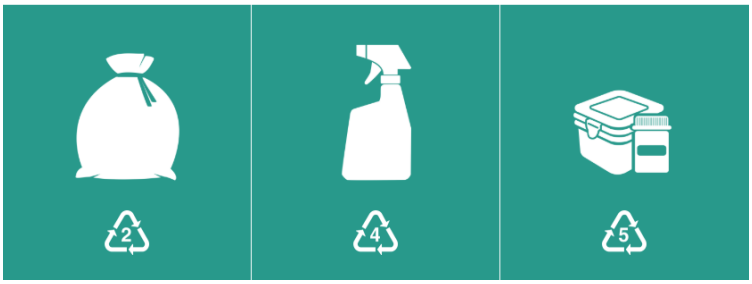
By improving after-use collection and further reprocessing and recycling of wasted materials in emergency areas could avoid the large potential beach and coastal cleaning costs. So far these costs are estimated to reach € million 630 per year in Europe alone.[97]

PCEP - a circular economy platform for the polyolefin industry

PCEP
POLYOLEFIN
Circular Economy Platform

Polyolefins are the largest class of synthetic polymers made today, and include Low-density polyethylene -LDPE-, Linear low-density polyethylene -LLDPE-, High-density polyethylene -HDPE-, and Polypropylene -PP- plastics.

[92] UN. (2014). *Valuing Plastic: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry*. pp 25.
Retrieved July 30, 2018, from http://wedocs.unep.org/handle/20.500.11822/9238
[93] IDEM, pp 24.
[94] Ellen Mac Arthur. (2018). *Eleven Companies Take Major Step Towards a New Plastics Economy*. News. Retrieved August 29,2018, from https://www.ellenmacarthurfoundation.org/news/11-companies-take-major-step-towards-a-new-plastics-economy
[95] EC. (1999). *Reuse of Primary Packaging*. Retrieved August 15, 2018, from http://ec.europa.eu/environment/waste/studies/packaging/reuse_main.pdf
[96] UN. (2014). *Valuing Plastic: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry*. pp 20. Retrieved July 30, 2018, from http://wedocs.unep.org/handle/20.500.11822/9238
[97] EC. (2015). *Our Oceans, Seas and Coasts: 10: Marine Litter*. Retrieved August 30,2018, from http://ec.europa.eu/environment/marine/goodenvironmental-status/descriptor-10/index_en.htm. Based on exchange rate of EUR 1 to USD 1.10 (10 December 2015).



Polyolefins account for 50% of the total amount of plastics consumed in Europe, and 70% of plastic packaging, representing 40% of European plastics demand application wise. 27 million tonnes of post-consumer plastic waste were collected in Europe in 2016 from which about 16 million tonnes are polyolefin, of which 75% were packaging waste.

Initially launched by the polyolefin producers, converters and recyclers, PCEP was created to strengthen value chain cooperation in the sector to foster the circular economy.
Within the scope of the platform, this year PCEP will:

- Announce an industry-wide 2030 roadmap to reach **60% recycling and reuse of collected Polyolefin (PO)** packaging.
- **Work collaboratively** with all relevant stakeholders in Europe to **have more than 75%** of all PO packaging **readily designed-for-recycling** by 2030.
- Work collaboratively with all relevant stakeholders of the waste management value chain in Europe, including municipalities and collection schemes, with the **aim to collect all PO packaging**, to sort them to produce a high quality/value feedstock for the PO value chain.
- **Prepare an annual reporting system** and invite the EU legislators to challenge and scrutinise PCEP progress on a yearly basis.

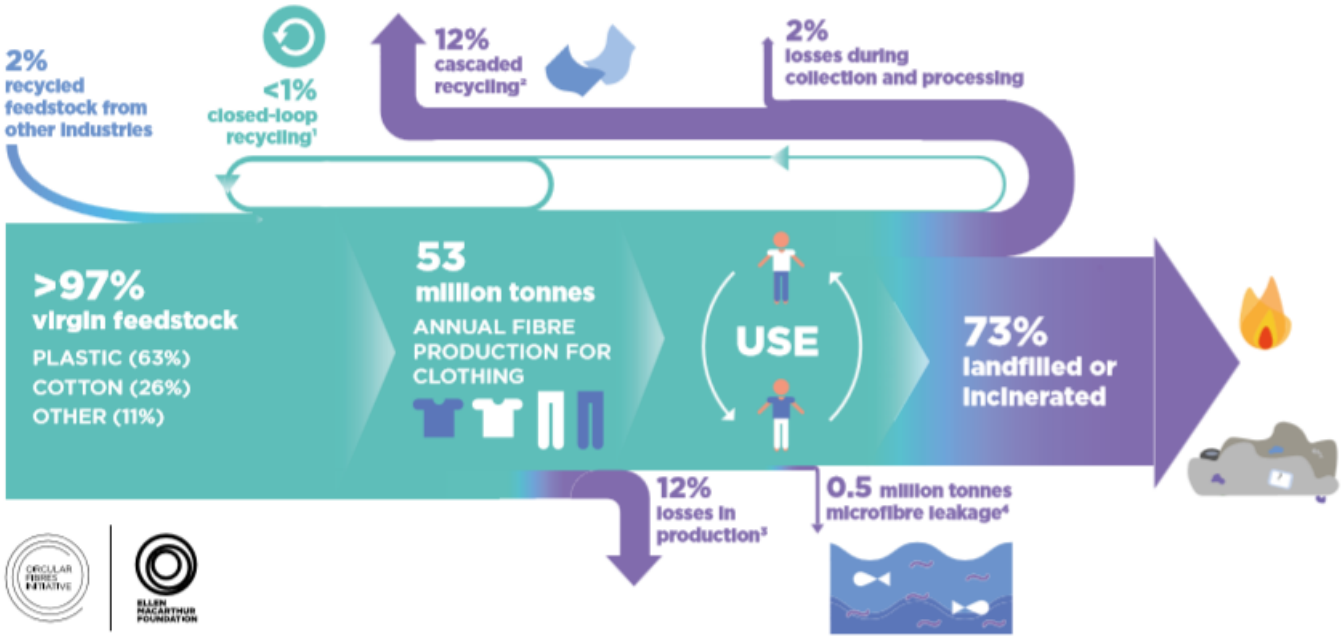
3.8 Textile

In 2017, the 176,000 European companies in the textile and clothing (T&C) sector were employing 1.7 million workers. The sector presents a turnover of € billion 181, and investments of € billion 4.9. The overall market value of the apparel and footwear industry in Europe is estimated at € 335.1 billion.[98] Concerning import-exports trends, the EU imported T&C products for a value of € billion 112, and exported for € billion 48, making the continent a net importer. [99] Worldwide, the fashion industry is estimated to have a total market value of € 3 trillion.[100]

Since the beginning of the 21st century, clothing manufacturing has doubled. By 2030, at the current rate, fashion consumption will have increased by 63%.[101] The 'fast fashion' phenomenon is a large cause of this exponential growth, coupled with growing trends in population and middle-class in emerging markets.

[98] Statista. (2017). *Clothing and Apparel Market in Europe.* Retrieved September
[99] Euratex. (2017). Key Figures 2017- The EU-28 Textile and Clothing Industry in the year 2017.
[100] Fashion United. (2017). *Global Fashion Industry Statistics- International Apparel.* Retrieved September 10,2018, from https://fashionunited.com/global-fashion-industry-statistics
[101] Global Fashion Agenda and Boston Consulting Group. (2017). *Pulse of the Fashion Industry*. Retrieved August 27,2018, from http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_2017.pdf

Figure 9: Global material flows in 2015[102][103]



1 Recycling of clothing into the same or similar quality applications
2 Recycling of clothing into other, lower-value applications such as insulation material, wiping cloths, or mattress stuffing
3 Includes factory offcuts and overstock liquidation
4 Plastic microfibres shed through the washing of all textiles released into the oceans

Today's fashion industry is still almost entirely operated in a linear model. Large amounts of resources -renewable and non-renewable- are extracted and exploited to produce clothes that are often times used for very short periods of time. When thrown away, 87% of them are sent to land-fill, or incinerated, while only 1% is recycled in a circular loop, and 12% recycled into low-value materials. With such a production and consumption model, because of under-utilised clothes and lack of recycling, more than $ billion 100 are lost annually worldwide.[104]

The economic value of the negative externalities is difficult to quantify, although the "Pulse of the Fashion Industry" report estimated that the overall annual benefit to the world economy could be € 161 billion in 2030 -land use externalities excluded-, if the fashion industry were to address the environmental and societal externalities of the current system. [105] This represents roughly 11% of the current retail value of both the apparel and footwear industry.[106] The same study projects that by 2030 fashion brands would see a decline in earnings before interest and tax (EBIT) margins of more than three percentage points, if they were to continue with a business-as-usual model. This would translate into a profit reduction of approximately € 45 billion for the industry.[107]

There are numerous ways the industry could overcome the negative externalities and predicted downshifting profits, and these solutions are intrinsically rooted in a radical conversion of the industry. In the following lines, future business disruptors and necessary transitions extracted primarily from the Ellen Mac Arthur

[102] Ellen Mac Arthur Foundation. (2017). *A new Textiles Economy: Redesigning Fashion's Industry*. pp 37. Retrieved August 12, 2018 https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf
[103] Microfibre leakages' estimates widely vary depending on the study.
[104] IDEM. pp 91.
[105] Global Fashion Agenda and Boston Consulting Group. (2017). *Pulse of the Fashion Industry*. pp 18. Retrieved August 27,2018, from http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_2017.pdf
[106] IDEM, pp 20
[107] IDEM, pp 23

Foundation study "A new Textiles Economy: Redesigning Fashion's Industry"[108] are presented, and further discussed.

1) Drop of hazardous and high-impacting chemicals and microfibre release

Innovation in this segment of the industry is undergoing some major changes, and very little data is available for a clear analysis. Major change in the **type of fabrics**, and the **way that these are fabricated** will however determine the future of fashion for the safety in material cycles, microfibres leakages, and other negative impacts.

Just recently the H&M Foundation announced the new winners of the Global Change Award. The prizes were given to ground-breaking start-ups developing what could become part of the future of the fashion industry. In the list, we find Agroloop which developed clothes from crop waste materials -such as pineapple, banana, or sugarcane-, or Algae Apparel and Fungi Fashion, making fabrics out of mushrooms and algae.[109]

2) Disrupting the buy-use-throw cycle

Clothing **rental** is predicted to become a major disruptor in the industry and represents a huge opportunity for businesses and for environmental impacts. A market analysis study by Allied Market Research, calculated the current value of the global online clothing rental market in 2017 to amount to more than $ 1 billion, and predicted a 56% increase in value by 2023. In the report, Europe was found to be having the second biggest market value after the US.[110]

Durability of clothing is already a strong business strategy for a number of major brands, such as Patagonia, Eileen Fisher, and Levi's and have shown very encouraging results in terms of market share and profitability. Patagonia's sales revenues, for example, has seen double-digits annual growth with gross profits of $ 600 million in 2015.[111]

Clothing **utilisation** could be increased by brand commitments and targeted marketing strategies. This way clothing capture value would drastically increase, while lowering pressure on resources and the environment. By only doubling the time a garment is used, GHG emissions derived from the overall production chain of the same garment would be almost 44% lower.[112]

3) Radically improve recycling by transforming clothing design, collection, and reprocessing

Recycling is still enormously underutilized in the sector, but initiatives are being slowly initiated from major fashion and retailer actors. Retailers like Target are now collaborating with I:CO offering a 20% discount on new denim clothes if customers give back their old denims. Levi's has been using a similar strategy already

[108] Ellen Mac Arthur Foundation. (2017). *A new Textiles Economy: Redesigning Fashion's Industry*. Retrieved August 12, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf

[109] Sustainable Brands. (2018). *H&M Names 5 Sustainable Fashion Start-ups that could Change the Face of Fashion.* Retrieved September 14, 2018, from https://www.sustainablebrands.com/news_and_views/product_service_design_innovation/sustainable_brands/hm_names_5_sustainable_startups

[110] Allied Market Research. (2017). *Online Clothing Rental Market by End-Users (Women, Men, and Kids) and Clothing Style (Ethnic, Western, and Others) - Global Opportunity Analysis and Industry Forecast, 2017-2023*. Retrieved September 10,2018, from https://www.alliedmarketresearch.com/online-clothing-rental-market

[111] Fortune. (2015). *Patagonia Financial and News*. [online web] Retrieved September 13, 2018, from http://fortune.com/change-the-world/2015/patagonia-24/

[112] Ellen Mac Arthur Foundation. (2017). *A new Textiles Economy: Redesigning Fashion's Industry*. pp 46. Retrieved August 12, 2018 https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf

for a couple of years, offering a $ 10 coupon for every jeans brought back to the store.[113] Stimulating customers for recycling, and designing new clothes to enable recycling processes goes therefore hand-in-hand.

4) Technological advancement

Technological innovations will allow to improve the quality of recycling, and finding new effective solutions for replaceability, recycling and re-use of materials, as well as finding new kind of clothing materials able to present more sustainable solutions to current virgin resources.

RECOVER- an upcycling expert's story

RECOVER is a trademark of Hilaturas Ferre, a Spanish family-run yarn spinning company founded in 1947. Since the very early days, Ferre decided to differentiate itself by basing its production on recycled materials, producing yarns out of textile waste. It is in 2006 that this process is branded and launched as the Recover initiative, which to this days has demonstrated to represent one of the most important actors in the textile's recycling industry. Only in 2017, the company has recycled 2.9 million kg of textiles, mostly from pre-consumer waste saving, inter alia, 60.7 million kg of CO2, 43.1 billion litres of water and 7.2 million m² of landfill space. The recycling of textile waste is therefore at the forefront of the fight against the depletion of resources and the current impacts of the industry on the environment and local communities.

For the production process, all collected scraps (or clippings) of textile waste are sorted and piled with other scraps of the same colour. The fibres coming out of the recycling process are blended with polyester fibres, made from recycled PET bottles, to improve the quality and breaking strength of the final product.
During the interview conducted to one of Recover's executives, it came however as a surprise that the company's growth is not on a par with the optimistic expectations that many might be currently foreseeing for the sector.

Demand for yarns from recycled materials still remains limited within major fashion players, and this, according to our interviewee, can mainly be attributed to two factors. On one hand, leading brands are currently running a price-war: a difference of a few cents can easily deter major companies from purchasing slightly more expensive yarns, as is often the case for Recover. On the other hand, there is a major market price dysfunction determined by the traditional system: the market price showcased for yarns is the one for undyed products, as yarns are typically sold undyed. Companies like Ferre however, create yarns from already dyed textile. It remains a challenge for the company to efficiently market their products, as the undyed yarns sold on the market are logically cheaper- as they still have to undergo the dying processes. **Market adaptation to new production systems is then needed in the sector to support a fast and efficient transition**.

Furthermore, in order for companies like Ferre to be able to operate more smoothly and without the current market barriers, the interviewee believes that an **Extended Producer Responsibility (EPR) scheme**

[113] Sustainable Brands. (2018). *Trending: New Technologies, Recycling Schemes, Materials Edge Fashion Industry Closer to Circularity*. Retrieved September 13, 2018, from https://www.sustainablebrands.com/news_and_views/product_service_design_innovation/sustainable_brands/trending_new_technologies_recycl

should be considered. Discounts on the scheme's fees should therefore be envisioned for companies that start adopting yarns from recycled or upcycled materials.

Following are the main barriers experienced by the company:

1. Financial barriers: Competing and comparing with commodity industry of virgin cotton and polyester is difficult.
   a. Industry very price driven and do not want to / can't pay more for sustainability.
   b. Price point Recover coloured yarns not compared correctly with other undyed yarns.
   c. Lack of incentives or regulation to promote recycling / use of recycled materials. Virgin commodity industry is in some cases subsidized creating non level playing field.
2. Quality barriers: Recycled quality is not the same as virgin quality
   a. Some irregularities due to recycling process / quality not equal to virgin due to shorter fibre.
   b. Supply chain and brands find it still difficult to work with this material that is less homogeneous than virgin product. Keeping traditional standards which are not always feasible for recycled.
3. Operational barrier: most of the large brands work with very compacted supply chain players that are vertically organized and put barriers to the use of third party yarns. Mainly in far East Countries where transit time from Spain is also a big barrier for service on time.

3.9 Electronics

In 2018, the consumer electronics segment in the EU amounts to $ million 59,533, representing 20% of the global market value.[114]

Out of the more than 10 million tons of products "put on the market" in Europe, only 3.8 million tons, or 38%, are recycled.[115] From 2016 the EU's collected rate of WEEE was set to 45%, but this result hasn't been achieved due to several countries still struggling to keep up with the legislation.[116] Northern Europe is the area hosting the most advanced countries in e-waste management in the world. However, its e-waste recycling rates do not even reach 50%.[117] The rest of the 6.2 million tons of waste are either exported, recycled under non-compliant conditions, or simply discarded.

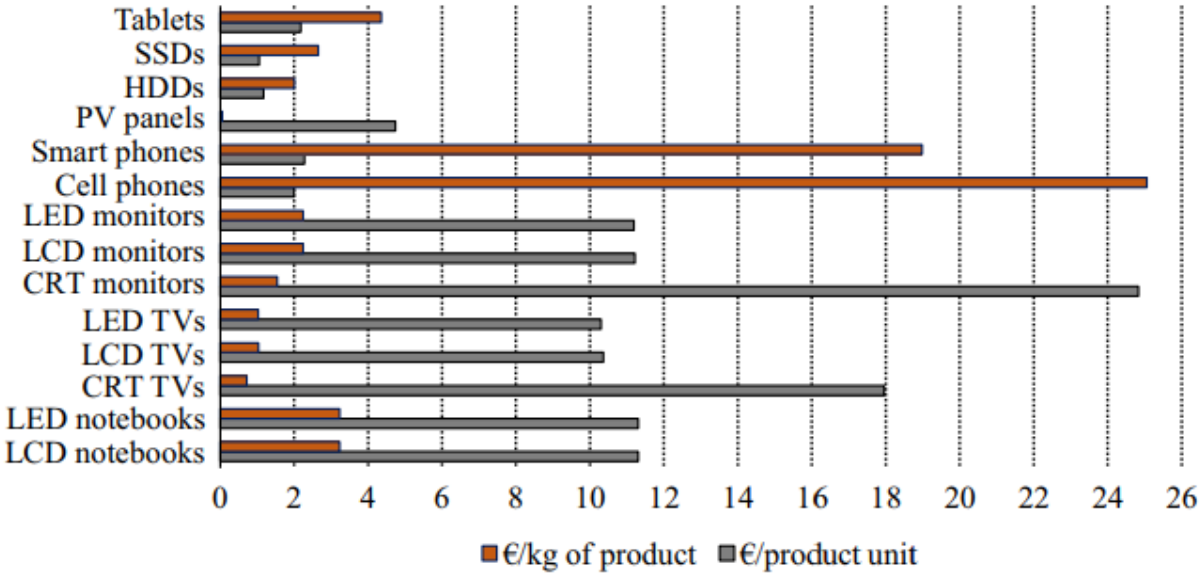
The UN estimated that in 2016, global raw materials in e-waste were worth € billion 55.[118] In 2016, global e-waste amounted to 44.7 million tons, 14% of which was European. By conducting an AS IS and TO BE analysis, a study by Cucchiella et al. estimated the EU recycling WEEE's potential to be equal to billion € 2.15-3.67 by 2020.[119]

The same study by Cucchiella et al.[120] calculated the recovery economic potential of numerous electronic devices. The calculations were made taking into consideration the material composition of the electronic devices with the related market prices in 2014.

The results of the study can be summarised through the following figure 10.

[114] Statista. (2018) . Consumer Electronics-Europe. Retrieved October 4, 2018, from https://www.statista.com/outlook/251/102/consumer-electronics/europe
[115] Eurostat. (2016). *Waste electrical and electronic equipment (WEEE) by waste management operations. Data.*
[116] EC. (2015). *Waste electrical and electronic equipment, total collected, 2015 (kg per inhabitant)*.Retrieved October 3,2018, from https://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics_-_electrical_and_electronic_equipment
[117] Baldé, C.P., Forti V., Gray, V., Kuehr, R., Stegmann,P.(2017). *The Global E-waste Monitor – 2017*. United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna. pp. 72. Retrieved October 3, 2018, from https://collections.unu.edu/eserv/UNU:6341/Global-E-waste_Monitor_2017__electronic_single_pages_.pdf
[118] IDEM, pp. 4.
[119] Cucchiella F., D'Adamo I., Koh S. C. L. & P. Rosa. (2015). *Recycling of WEEEs: an economic assessment of present and future e-waste streams*. Renewable and Sustainable Energy Reviews. 51: 263- 272. pp 271.
[120] IDEM.

Figure 10: potential revenues of different WEEEs[121]



As shown, depending on the reference index, potential revenues for the same product can be very different. When recycling potential revenues are calculated following a "€/kg of product" index, smartphones and cell phones are by far the most valuable WEEE products currently on the market. When considering a "€/product unit" index, CRT monitors, CRT TV's, and notebooks are the most valuable. On the other hand, when looking at the TO BE analysis conducted, which predicts future revenue scenarios for the same type of WEEE, smart phones, LED monitors, LED TVs, LCD TVs become the most promising WEEE.[122] Due to technology limitations and low economic incentives to recycle, however, many of the WEEEs' recycling remains economically unviable, or hard to recycle.

Furthermore, an extensive study conducted at CEPS by Drabik et al. looked at a relatively young WEEE, namely electric vehicle batteries.[123]

By 2030, approximately 1.2 million EV batteries are expected to reach their end-of-life, and by 2040 they are expected to amount to 5.4 million. According to the study, achieving high recycling rates for EV batteries in Europe can help decrease dependency on imported resources and retain value of recovered materials In the economy. Through recycling, it estimated that in 2030, under scenario 1[124], the EU would recover € million 408 and create 2,618 jobs. Under scenario 2[125], at current prices, € million 555 would be recovered, and 3,272 jobs would be created.[126] Nevertheless, degraded EV batteries can still retain up to 80% of their capacity after use, so their reuse, for example for energy storage purposes, could represent a more optimal option.[127]

[121] IDEM, pp 268.
[122] IDEM, pp 268.
[123] Drabik E., Rizos V. (2018). *Prospects for electric vehicle batteries in a circular economy.* Retrieved September 25, 2018, from https://www.ceps.eu/publications/prospects-end-life-electric-vehicle-batteries-circular-economy
[124] Collection/take back rate for recycling within the EU: 65%; Cobalt recycling efficiency rate: 94%; Nickel recycling efficiency rate: 95%; Aluminum recycling efficiency rate: 98% ; Lithium recycling efficiency rate: 57%.
[125] Collection/take back rate for recycling within the EU: 85%; Cobalt recycling efficiency rate: 99%; Nickel recycling efficiency rate: 97%; Aluminum recycling efficiency rate: 98% ; Lithium recycling efficiency rate: 94%.
[126] Drabik E., Rizos V. (2018). *Prospects for electric vehicle batteries in a circular economy.* Retrieved September 25, 2018, from https://www.ceps.eu/publications/prospects-end-life-electric-vehicle-batteries-circular-economy
[127] Ramoni M., Zhang H-C. (2013). *End-of-life (EOL) issues and options for electric vehicle batteries*. Retrieved December 9,2018, from https://www.researchgate.net/publication/236649811_End-of-life_EOL_issues_and_options_for_electric_vehicle_batteries

In terms of costs of investment, to develop better recycling and refurbishing systems for electronic devices, the literature still does not present comprehensive data. In the "In an Initial Exploration" study by the Ellen Mac Arthur Foundation[128], it is stated that disassembly, refurbishment and recycling are labour intensive processes. Investments might therefore target **robotics and machine learning technologies** to cut down on long-term costs and exploit the financial opportunity. On the other hand, other developments for the circular economy in the electronics sector are believed to be those that reduce the demand of materials:

1.Design to increase the durability of materials.

2.Increase incentives increase data cloud migration (reduces the impact of hardware obsolescence).

3.Increase use of second-hand market efficiency (for a better transparency, product specifications and conditions, and traceability). The second-hand market is in growing in the EU and expected to generate a global revenue of $ billion 30 by 2020.[129]

4.Increase automation in disassembly and refurbishment processes (to foster a more successful recycling and re-use market, and durability of products). The repair and refurbishment market has already a yearly turnover of € billion 30, € billion 3.1 of which coming from EEE.[130]

iameco- the first European fully circular computer

With the one and only computer in the world being assigned the EU Eco Flower Certification, iameco wants to represent the future for electronics. A future of **European-made**, **low-carbon**, **recycled**, **durable**, **easily repairable** and **recyclable**, **modular** and **upgradable**, and **aesthetically appealing** computer devices.

While not being sold on the market yet, one of the products being currently proposed, the iameco D4R, has been designed using Zero WIN -Zero Waste in Industrial Products- principles, and boasts 70% of materials recycled or reused, a reduction of 75% of fresh water, and 30% decrease in GHG emissions throughout the production process. The environmental impact was calculated by the Fraunhofer Institute through a Life

[128] Ellen Mac Arthur Foundation. (2017). Circular Consumer Electronics: An Initial Exploration. Retrieved September 23, 2018, from https://www.ellenmacarthurfoundation.org/assets/downloads/Circular-Consumer-Electronics-FV.pdf

[129] International Data Corporation. (2016). Press Release: "Worldwide Market for Used Smartphones Forecast to Grow to 222.6 Million Units in 2020, According to IDC", https://www.idc.com/getdoc.jsp?containerId=prUS41929916 ; International Data Corporation, Document at a Glance: "Worldwide Used Smartphone Forecast 2016-2020", October 2016, http://www.idc.com/getdoc.jsp?containerId=US41737016 .

[130] European Remanufacturing Network (2015). *Remanufacturing Market Study*.

Cycle Assessment (LCA).[131] On top of that, iameco computers' lifespan are stated to be 7-10 years, compared to 2-3 years for conventional brands.

iameco has a clear vision for the future of electronics, and at its core, its innovative value chain strategy. The Irish start-up plan is to base its manufacturing plants in Europe, supporting a **network of small-scale digital manufacturing centres throughout all Member States**. iameco's Managing Director, Paul Maher, envisions these centres as being the main facilities for iameco's manufacturing and repairing services, and are being designed to create short loop cycles of resources, ensuring that both valuable materials and jobs stay in the European Union.
While the design and conception of its main produce are already completed, iameco is currently working on the financial aspect of its operations, looking for investors able to support the scale-up of its concept, and enable to develop its service centres throughout Europe. More financial interest is therefore needed for initiatives such as iameco to successfully enter in the competitive European market.

[131] Ospina, J., Maher, P., Schischke, K. and Schlösser, A. (2012). *Environmental Product Assessments for Small Computer and Laptop Companies – MicroPro's Experience with Eco-Design of Product Service Systems*. Retrieved from http://iameco.com/wp-content/uploads/2013/10/EGG-Paper-MicroPro-Final-Draft.pdf

4. Conclusion

The report offers an overview of the trends, the investment and cost saving opportunities, but also the challenges for nine industrial sectors to transition to a circular economy. Despite the limitations encountered to gather relevant and clear data for each sector, figures in the literature support the concept of a circular economy both from an environmental as well as economic perspective. It is now the "how" and "when" that will determine whether this concept will bring overall positive benefits and opportunities for the entire economy.

As a conclusion of this report, a couple of points can be drawn in order to "fully close the circle":

- Vast expansive investments are needed in order to convert our current linear model to a circular system. However, most studies indicate that there is a positive profit potential to be expected in the long term;

- A cultural mind-shift will have to be considered if we want that collective interests are directed toward the most promising technologies and innovations, as well as consumption patterns. A large portion of the investments that the industry will need to envision can be considered as a long term strategy for competitiveness and resilience against raw materials' price surges;

- In order to attain a fully circular scenario, preventive measures should always be prioritized against corrective ones. This means that durability, reducing, leasing, reusability, and repairability should be prioritized before recycling; to accomplish these, careful product design and alternatives to single-use or short-lived products are essential factors for success recurring in all the sectors analysed;

- Public and private investments should be oriented toward those measures that enable such solutions to be implemented;

- The interviews, some of which conducted with innovative start-ups, stress upon the importance of higher financial and regulatory incentives for circular business models, specifically targeted EPR schemes and green public procurement;

- Direct legal requirements such as eco-design rules, although mainly targeted towards the producers of final goods, may have indirect effects on upstream and intermediary industries. Regulation and incentives have to take into account the potential impacts on upstream, downstream and intermediary activities;

- The communication and collaboration in industrial synergies between the numerous stakeholders in each sector should be stimulated in order to get the best possible outcomes. This can be provided by creating local collaborative platforms, hubs, and clusters that incentivize partnerships between the different actors in the value chain.

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6. ANNEX

Table 3: Briefing Table

SECTORS	QUANTITATIVE RESULTS[132]	BEST PRACTICES	SOURCES
Metal Manufacturing	€ billion 570 investment costs in the first year and in the overall sector, economic benefits for all EU-27 result to be € billion 44-82 per year.	-**Ecodesign (using same material)** -**Ecodesign (change of material)** -**Material reuse** -**Waste prevention**	Amec & Bio Intelligence Service. (2013)
Food & Drink Manufacturing	Estimated costs account for about € billion 760 for the whole sector. Annual (gross) benefits for the sector in the 27 EU member states are € billion 64 – 118.	-**Waste recover technology (eg. Anaerobic digestion)** -**Ecodesign (using same material)** -**Ecodesign (change of material)** -**Waste prevention - food**	Amec & Bio Intelligence Service. (2013)
Agriculture	Estimate of € billion 72 opportunity to be invested by 2025, to rip benefits of € billion 127 between 2016-2030.	-Regenerative agriculture practices (cost: € billion 15 between 2016-2025; benefit: € billion 35 annually by 2030) -New Protein sources (cost: € billion 2 between 2016-2025; benefit: € billion 40) -Urban farming (cost: -Compost plants (cost: € billion 10 between 2016-2025; benefit: € billion 2)	Ellen Mac Arthur (2017)- Achieving Growth Within
Hospitality & Food Services	With a total sector's investment rounded to € billion 100 , the total annual benefit for the sector is € billion 64-118. Companies will receive average net benefits of € 27,500, equal to 10% of the average turnover in the year previous to the study.	-**Procurement** -**Waste prevention** -**Choice of smaller portions** -**Seasonal food**	Amec & Bio Intelligence Service. (2013)
Mobility	-If we exclude externalities, which comprise social and environmental costs, the sector has the potential to save up to € billion 310. Including externalities, the cost savings reach € billion 370. -The E. Mac Arthur Foundation estimates that with € billion 135 of investment, benefits would amount to € billion 280 between 2016-2030	-**Integrated electric sharable vehicles with public transportation** (costs: € billion 100 between 2016-2025; benefits: annually 175 billion € by 2030) -**Durable and high-value materials to enable loop of materials** (costs: € billion 35 between 2016-2025; benefits: annually € billion 75 by 2030)	Ellen Mac Arthur (2017)- Achieving Growth Within

[132] All results concern the EU economy, unless words appear in red and showcase global data.

		-**Remanufacturing of materials** (costs: € billion 1 between 2016-2025; benefits: € billion 30 annually)	
Construction	By investing € billion 107 between 2016-2025, Europe would be able to close the loop of materials in the construction sector and attain € billion 150 of benefits between the period 2016-2030.	-**Design and production of circular buildings, made of modular pieces, as well as renewable and recyclable materials** (cost: € billion 105; benefit: € billion 135 by 2030) - **Recycling and re-use of materials** (cost: € billion 2 between 2016-2025; benefit: € billion 15 by 2030)	Ellen Mac Arthur (2017)- Achieving Growth Within
Plastics	NO Cost-Benefit Analysis (CBA). -95% of plastic packaging material value, between € billion 70-105 , is lost to the economy after the first use. - The total natural capital cost of plastics in the consumer goods industry is estimated at € billion 56, of which € billion 30 billion -53%- was related to plastic packaging, a sum which exceeds the profit pool of the plastic packaging industry	-**Recycling** (profit between € 155-590 per ton of material) -**Packaging design** (profits up to 90-140 $/ton) -**Re-use and compostable plastic** (companies can attain 25-50% packaging cost savings, or $ billion 8, and 85-95% transportation cost savings)	-UN (2014) -McKinsey (2016)
Textile	NO CBA -Report estimated that the overall annual benefit to the world economy could be € 161 billion in 2030 -land use externalities excluded-, if the fashion industry were to address the environmental and societal externalities of the current system	-**Drop of hazardous and high-impacting chemicals and microfibre release** (change in type of fabrics and ways they are fabricated) -**Disrupt the buy-use-throw cycle** (through leasing, higher durability, and increase clothing utilisation) -**Radically improve recycling** (through collection, design, reprocessing)	-Global Fashion Agenda and Boston Consulting Group. (2017) -Ellen Mac Arthur (2017)- A new Textiles Economy
Electronics	NO CBA - EU recycling WEEE's potential estimated to be equal to annual billion € 2.15-3.67 by 2020.	1.Design to increase the durability of materials 2.Increase incentives to increase data cloud migration (reduces the impact of hardware obsolescence)	-Ellen Mac Arthur Foundation (2017) -Circular Consumer Electronics -Cucchiella et al.(2015)

		3.Increase use of second-hand market efficiency (for a better transparency, product specifications and conditions, and traceability) 4.Increase automation in disassembly and refurbishment processes (to foster a more successful recycling and re-use market, and durability of products) 5.Increase recycling	

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